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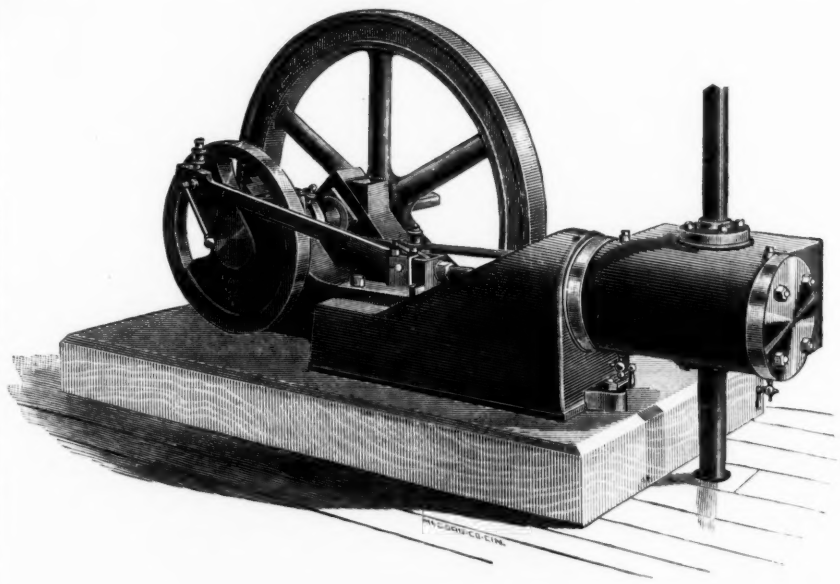
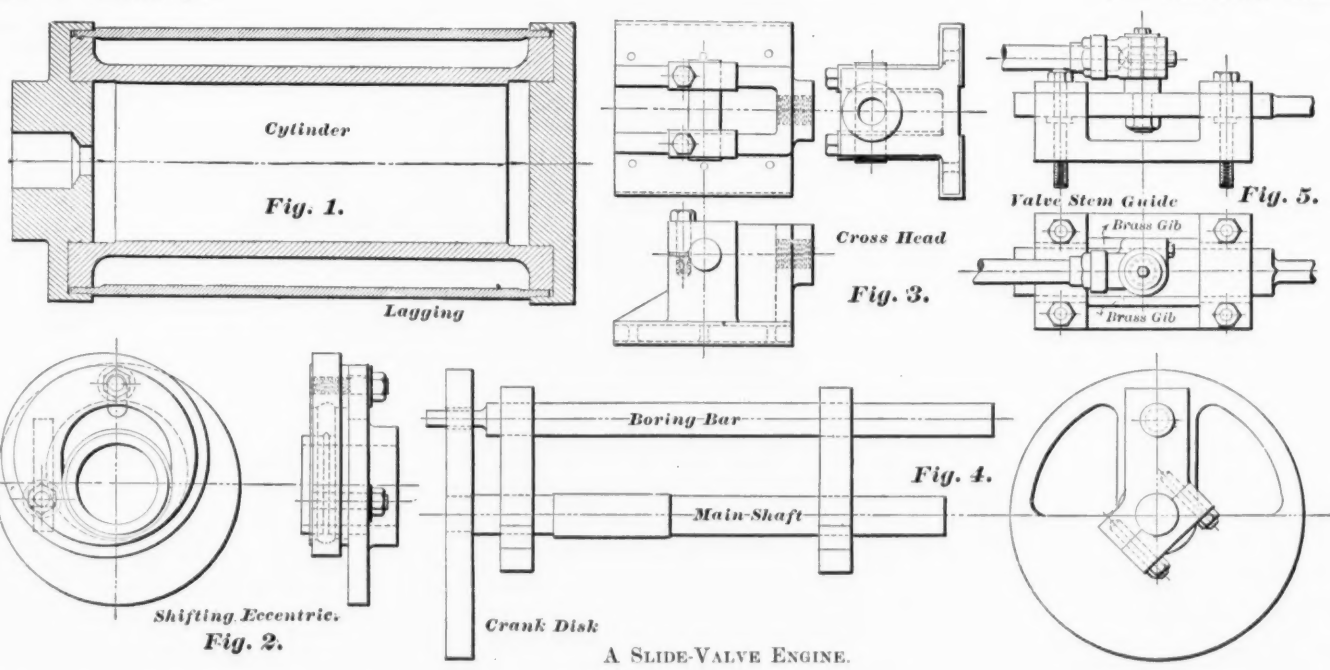
A Slide-Valve Engine.

MADE BY PUPILS OF THE CINCINNATI TECHNICAL SCHOOL.

The wood-cut and detailed drawings, on this and the next page, represent a 5″x12″ slide-valve engine, built during the past winter by pupils in the third and fourth years at the Technical School, Cincinnati. This school is a manual training school, intended for boys from 14 to 18 years of age; there are three shops connected with it—the carpenter, blacksmith, and machine shops, in which every boy works one year.

This engine was designed by the director, Mr. James B. Stanwood, to embody some modern ideas regarding engine construction, and also to have an engine that the pupils could build cheaply; it is of the self-contained type, and weighs about 1,000 lbs., including fly-wheel. The bed-plate is planed at the guides, at the "spot" to which valve-stem guide is bolted, and through the main bearings, to make fit for caps; the boring-bar for facing off the end, to which cylinder is bolted, is carried in boxes secured to the guides as indicated by Fig. 6, page 2; this also shows how the babbitting mandrel with its collars is brought in line. The ends of the main bearings are not planed, the babbitt metal forming the shoulders. The metal is poured so that it shrinks to casting, and not away from it. There are no forgings about the engine; the connecting rod is made from a piece of 3″ round machinery steel, turned first to shape, then planed to thickness. The crosshead, Fig. 3, has an inserted pin clamped as shown; its wearing surfaces are all babbitt metal, which was poured after crosshead was secured in place to piston rod, in position on the guides. The valve-stem guide is shown by Fig. 5; the brass gibs, top and bottom, extend its entire length; this guide permits of adjustment in all four directions—up, down, in and out. The eccentric is not keyed directly to shaft, but is bolted to a flange, which in turn is secured to shaft; this flange is slotted, so that eccentric can be regulated as to throw, the lead remaining constant for every position. The object of this construction is to give pupils some idea about shifting eccentrics; it also enables the engine to be adjusted to best conditions of cut-off and compression. The method of boring hole for crank-pin fit in disk is shown by Fig. 4; this is done after disk is pressed on and keyed to shaft.





A SLIDE-VALVE ENGINE.

Fig. 1 shows how cylinder lagging is attached. A piece of cast-iron pipe of the right size is turned up at its ends, and cut in halves longitudinally; it makes the lagging for two cylinders. The lagging can be attached without screws, the cylinder heads holding it in place.

This engine is now operating the shops of the school, speeded at 250 revolutions per minute; it is controlled by a Judson governor (not shown by cut); the power now developed is about 8 horse-power.

It is intended next year to build another engine, a duplicate of this one. Pupils will make sketches by direct measurement from this engine, from which working drawings will be prepared for their own use in the shops. Quite a number of some of the smaller details will be constructed, a selection being made for final use in the engine. Designs for a small side-by-side compound are also to be prepared for future shop work.

As is usual at this time of the year, we are hearing a great deal about crop failures, and, as usual, it is not wise to place too much confidence in such reports. No doubt there are partial failures in some parts of the west, and probably, as a whole, crops will not be as good this year as in some other years. But we do not think there is any such failure as will make serious impressions on general business.

Force in the Steam Engine and its Relation to Smooth Running.

BY PROF. JOSEPH TORREY.

At the time the action of inertia in the reciprocating parts of the steam engine was first investigated by Mr. Porter, the results seemed quite incredible, even to the best educated engineers. The demonstrations were all right, and yet the idea of a stationary body not being inert was too much. The abrupt and uncompromising termination of the inertia curve, as traced by Mr. Porter, indicated a condition of affairs at the ends of the stroke that seemed entirely contrary to all accepted ideas. I think it was Mr. E. F. Williams who first conceived the idea of experimentally testing the truth of the matter, and he actually did contrive a very ingenious little instrument, by which he demonstrated conclusively that the inertia curve, as mathematically traced, was a true representation of the actual action of the reciprocating parts. His instrument consisted of a weight of known mass, moving with the crosshead, but fixed to a spring of known tension, so that it was not immovable, and, of course, its momentum and resistance to being set in motion gave rise to small tensions and compressions of the spring, as the weight traveled back and forth with the crosshead. The amount of this tension and compression was recorded (by a small, light multiplying pencil lever attached to the weight) on a card fixed to an arc carried by a vibrating lever, the lower end of which was attached to the crosshead.

With this instrument cards were taken from several engines. Sometimes the diagrams were very smooth, and approached the theoretical inertia curve quite as closely as a good indicator card approaches theory. Others were not nearly as smooth, and showed abrupt rises in the curve which could not be ascribed to imperfections in the inertia instrument, and which, moreover, were constant for the same engine running under the same conditions. In case of engines that pounded, the curve was never smooth, but in cases where the engine ran smoothly and quietly, the curve was smooth also. In short, the instrument was a true index of the running qualities of the engine to which it was applied.

A description of the machine, together with diagrams taken with it, was published in the AMERICAN MACHINIST some time in 1884,* and attracted considerable attention. The instrument was patented, and the manufacture was undertaken by either the American Steam Gauge Company or the Crosby Steam Gauge and Valve Company, I forget which. The inventor appears to have had some hope that the instrument would be of use in the future in diagnosing pounding engines. I do not think it ever came into use. The fact is, that while the instrument would confirm the testimony of the ear as to pounding, so far as I know, it would give no clear indication of the cause, nor would it indicate internal faults not easily perceptible to eye or ear. The probability is that when it demonstrated, as it did for the first time experimentally, the correctness of the inertia curve, its work was done.

When the writer first began his studies in inertia, the Williams instrument was still a great curiosity. At that time it really seemed as if it was to be to one department of steam engineering what the indicator was to another. The only fault with the Williams instrument appeared to be its lack of portability and compactness. The writer spent considerable time and thought on an inertia instrument, which was finally completed roughly, and tried. It gave excellent results, and was of very small dimensions, and from its decided resemblance to the indicator it was called the "inertia indicator." It

* The articles referring to this will be found in our issues of Aug. 9, 23, 30, Sept. 13, Oct. 18, Nov. 1, 22 and Dec. 27, 1884.—ED.

was never patented, and would probably have infringed Mr. Williams' patent if it had. It was never manufactured, except the one made by the writer, who would not undertake the manufacture of another under any circumstances, so it cannot be said to have been a commercial success. As a curiosity in the history of engineering, it may merit a brief description.

The general shape of the instrument is shown in Fig. 1. The weight *w* plays on the spindle *s*. It is controlled by the spiral

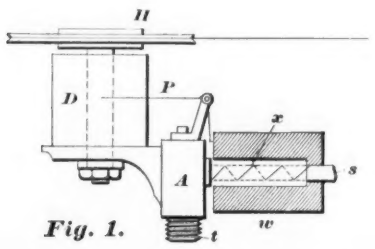


Fig. 1.

spring *x*, one end of which is fixed to the weight and the other to the standard *A*. At *D* is a revolving drum. It is caused to revolve in the following manner: The drum, of very thin brass tube, is fixed to an upright spindle, to which is attached a retractile spring, just as in the ordinary indicator. At the upper end of this spindle is secured strongly a thin, grooved wheel, made of pulp board or very light wood. The engine to which it was applied had a 12-inch stroke, and the wheel was 4″ in diameter. A string is attached to the grooved circumference, and carried directly backward to any stationary object, on a level with the wheel of course. Then, as the engine crosshead moves forward, the wheel and drum revolve, and as the crosshead returns, the spring acts to bring them back to their former position. In this case, since the diameter of the wheel is 4″, the circumference is 12.56″, so that the crosshead in traveling made nearly a whole revolution of the drum. The paper was held on the drum in such a way that this caused no inconvenience, and the wheel was thus kept at its lightest. At 250 revolutions there was no indication of fling, and the cord would not run off the wheel.

The instrument is screwed to the crosshead by the thread *t*, and can be held vertically or horizontally. The movement of the weight is transmitted through the pencil lever *p* to the paper drum. The neutral line is first drawn, turning the drum by hand, the weight being stationary. A little cam, controlled by a very small lever, which could be touched while the instrument was in motion, enabled the pencil to be brought to the paper whenever desired.

The general design of the instrument was very simple, but the details of construction and means of connecting parts so that the springs could be readily removed, and yet be absolutely rigid in their connections, together with countless other little details that will readily occur to any one familiar with such jobs, made its design a difficult matter. It would be pretty easy to construct now, for the details as finally determined are very simple. The object of this description, however, is not to urge its manufacture, for it would be of no permanent use or interest. It was perfectly evident to the writer, during the short time he was enabled to test it, that it was valueless as a detector of particular faults. It is apparently impossible that it should ever be valuable to the engineer in any such sense as the indicator is.

Moreover, the place where inertia needs to be taken into account, is in the design of the engine in the first place; and for proportioning the parts to give good results, mathematical calculation is close enough. Of course, such calculations must be made intelligently.

The questions of strength and rigidity involve a detailed knowledge of the amount and directions of the strains to be provided for, and may modify somewhat the results of calculations based on other considerations, but, in general, the reciprocating parts of steam engines can be and should be always made the subject of intelligent and thorough calculation. This is *not* common practice at present, and designers appear often not only to ignore, but distrust all conclusions drawn from calculations. A change in this respect would materially improve results.

Remarkable Marine Engineering Feat.

Few things are better calculated to show the almost incomprehensible difference between the older methods of marine engine practice and that of to-day than the rapidity with which engines and boilers of many hundreds of horse-power are now taken on board, put together, fixed, and got under steam. The steamship Rangatira, the largest vessel ever built in the Hartlepools, had her engines steamed for several hours on Wednesday, the 23d ult., on board the ship under the shear legs at the Central Engine Works. She was then taken back to Messrs. William Gray & Co.'s shipyard to receive her finishing touches, and the steamship Halifax City took her place under the shears to receive her engines. This is a steel vessel built by Messrs. Edward Withy & Co., for Mr. C. Furness, and is of the following dimensions: Length, 312 feet; breadth, 38 feet 6 inches; depth, 22 feet. She is built to the highest class at Lloyd's, and is of the raised quarter-deck type, with long bridge and topgallant forecastle. She has four steam winches, two donkey-boilers, steam steering gear, and steam windlass with stockless anchors hauling into hawse pipes, and other modern appliances. Her engines were built at the Central Marine Engine Works, and have cylinders 22 inches, 33 inches, and 60 inches diameter by 39-inch stroke. These engines are supplied with steam from two large steel boilers, about 14 feet diameter, working at a pressure of 160 pounds per square inch. The engines, boilers, shafting and propeller were all fitted on board, all pipes connected, engine-room floors, ladders, and gratings fitted, within three days of the time she was put under the shears, the engines being steamed at the shears for several hours on Saturday morning, and the vessel returned to Messrs. Withy's shipyard at 10 A. M. Her place was then immediately taken under the shears by the steamship Manchester, a vessel built by Messrs. W. Gray & Co., to the order of Messrs. Evan, Thomas, Radcliffe & Co., of Cardiff, which machinery will be similarly quickly shipped. These facts show what may be done wherever there are the facilities. It shows the value of adequate lifting and other appliances, and it is a matter of interest to shipowners and shipbuilders that at the port of the Hartlepools there are such excellent facilities for the rapid shipment and completion of machinery. The contrast between the three days which are now occupied for fitting on board and steaming the machinery of a large vessel by the use of hydraulic shear legs and other appliances, with the several weeks that used to be occupied by older methods, is as astonishing as it is explanatory of the success of the marine engineering of the port.—*London Engineer.*

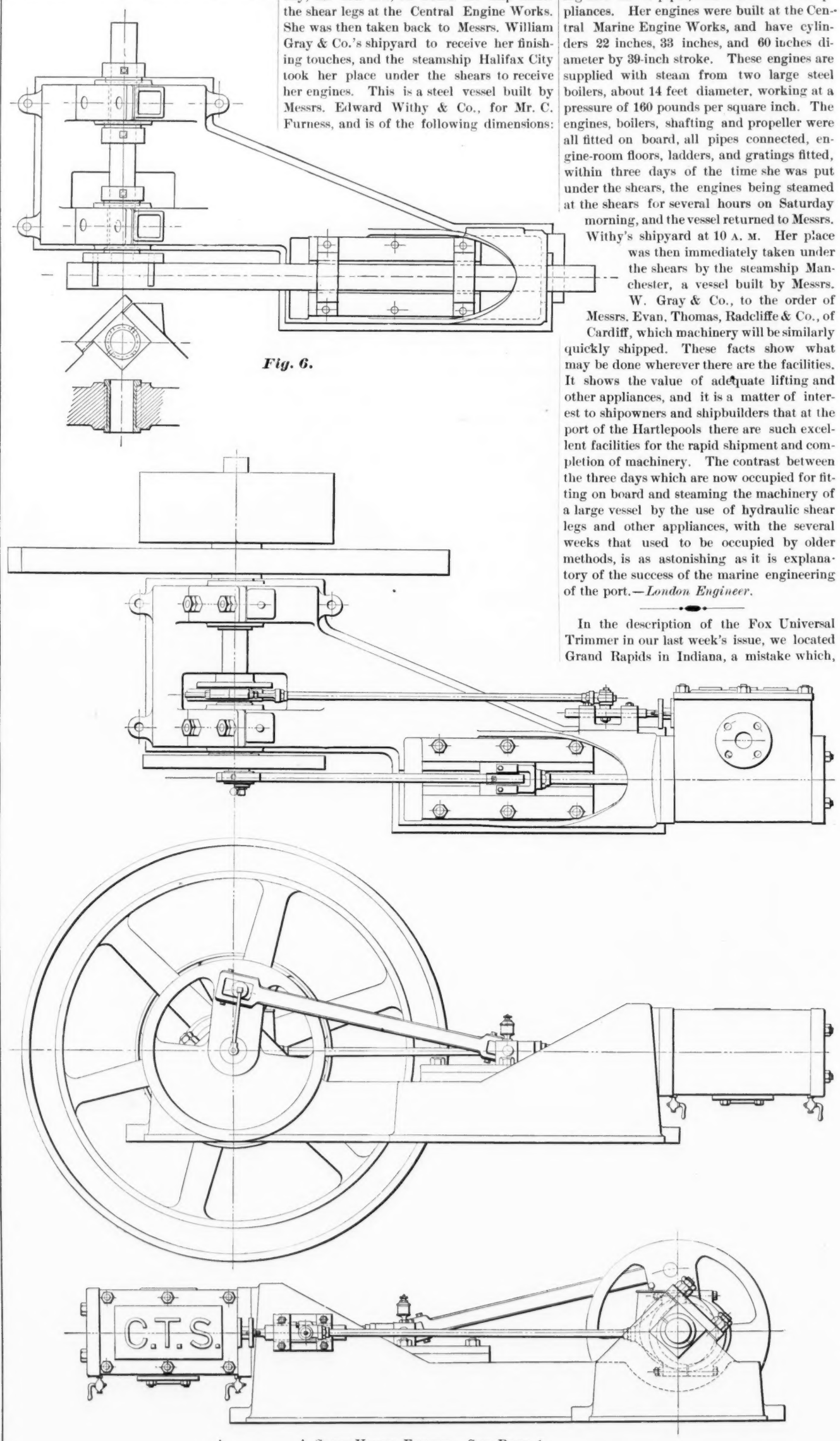


Fig. 6.

A Slide-Valve Engine.—See Page 1.

In the description of the Fox Universal Trimmer in our last week's issue, we located Grand Rapids in Indiana, a mistake which, we hope, will cause little or no trouble, however, as we take it that it is pretty generally known to be in Michigan.

Odontics, or the Theory and Practice of the Teeth of Gears.

By Geo. B. Grant.

TWELFTH PAPER.

(*Worm Gears Continued.*)

119.—CIRCULAR PITCH WORM TEETH.

The old and clumsy circular pitch system is in universal use for worm teeth, for the reason that worms are generally made in the lathe, and lathes are never provided with the proper change gears for cutting diametral pitches. The error is so firmly rooted that it is useless to attempt to dislodge it.

It is therefore necessary to figure the diameters of worm gears as if their throat sections were the same as those of common spur gears and racks on the circular pitch system. The table of diameters (35) will be of great assistance.

One great objection to the use of the circular pitch system for spur gears does not apply to worm gears, that the center distance between the shafts will always be an inconvenient fraction, unless the pitch is as inconvenient. The worm can be made of any diameter, and can therefore be made to suit the pitch diameter of the gear and the center distance at the same time.

The sides of the tool for circular pitches should come together at an angle of thirty degrees, and the width of the point, as well as the depth to be cut in the worm or in the hob, should be taken from the following table. The diameter of the hob should be greater than that of the worm by the "increase" given.

TABLE FOR CIRCULAR PITCH WORM TOOLS.

Circular pitch	2	1¾	1½	1¼	1⅛
Point of hob tool	.644	.564	.483	.402	.302
Point of worm tool	.620	.542	.466	.388	.349
Depth of cut in worm or hob	1.416	1.240	1.062	.886	.797
Increase	.166	.146	1.249	.104	.094
Circular pitch	**1**	**⅞**	**¾**	**⅝**	**½**
Point of hob tool	.322	.282	.241	.201	.161
Point of worm tool	.310	.271	.233	.194	.155
Depth of cut in worm or hob	.708	.620	.531	.443	.354
Increase	.083	.073	.062	.052	.042
Circular pitch	**⅜**	**¾**	**⅛**	**¼**	**⅛**
Point of hob tool	.141	.121	100	.080	.060
Point of worm tool	.135	.116	.097	.078	.058
Depth of cut in worm or hob	.310	.265	.222	.177	.133
Increase	.036	.031	.026	.021	.016

Make the tool with the proper width at the point to thread the worm, and then, after making the worm, grind off half the "increase" from the length of the tool, and use it to thread the hob.

120.—DIAMETRAL PITCH WORM TEETH.

If the proper change gears are provided, it is as easy to cut diametral pitch worm teeth as any. The proper gears can always be easily calculated by the rule that the screw gear is to the stud gear as twenty-two times the pitch of the lead screw of the lathe is to seven times the diametral pitch of the worm to be cut.

For example, it is required to cut a worm of twelve diametral pitch, on a lathe having a leading screw cut six to the inch. We have

$$\frac{\text{screw gear}}{\text{stud gear}} = \frac{22 \times 6}{7 \times 12} = \frac{11}{7};$$

and any change gears in the proportion of 11 and 7 will answer the purpose with an error of $\frac{1}{10,000}$ of an inch to the thread of the worm.

If 22 and 7 give inconvenient numbers of teeth, the numbers 69 and 22 can be used with sufficient accuracy, and 47 and 15, or even 25 and 8 may do in some cases.

To save calculation and study, the table of change gears for diametral pitches is provided, and it will give the proportion of screw gear to stud gear to be used for all ordinary cases.

The pair on the left will give the proper pitch within less than a thousandth of an inch, and that on the right will serve with an error always less than a hundredth of an inch, and sometimes less than two or three thousandths of an inch.

Having the change gears, figure the pitch diameter of the gear as if the throat section is a spur gear on the diametral pitch system.

The sides of the tool should come together at an angle of thirty degrees, and the width of the point of the tool, as well as the depth to be cut in the worm or in the hob, should be taken from the following table. The diameter of the hob should be greater than that of the worm by the "increase" given.

TABLE FOR DIAMETRAL PITCH WORM TOOLS.

Diametral pitch	1	2	3	4
Point of hob tool	1.035	.517	.345	.258
Point of worm tool	.968	484	.323	.242
Depth of cut in worm or hob	2.125	1.063	708	.532
Increase	.250	.125	.083	.063
Diametral pitch	**5**	**6**	**7**	**8**
Point of hob tool	.207	.173	.148	.129
Point of worm tool	.194	.162	.138	121
Depth of cut in worm or hob	.425	.354	.304	.266
Increase	.050	.042	.036	.032
Diametral pitch	**10**	**12**	**14**	**16**
Point of hob tool	.104	.086	.074	.065
Point of worm tool	.097	.081	.069	.060
Depth of cut in worm or hub	.213	.177	.152	.133
Increase	.025	.021	.018	.016

Make the tool with the proper width at the point to thread the worm; and then, after making the worm, grind off half the "increase" from the length of the tool, and use it to thread the hob.

121.—WIDTH OF WORM GEAR FACE.

The bearing between the tooth of the worm and that of the gear is near the center of the gear, and it is quite small (104). It is, therefore, useless to make the gear with a wide face. If the face is half the diameter of the worm it will have all the bearing that can be obtained, and any extra width will simply add to the weight and cost of the gear.

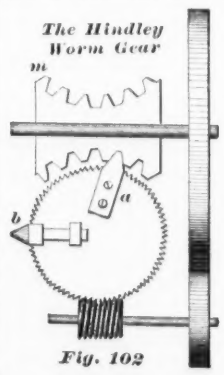


Fig. 102

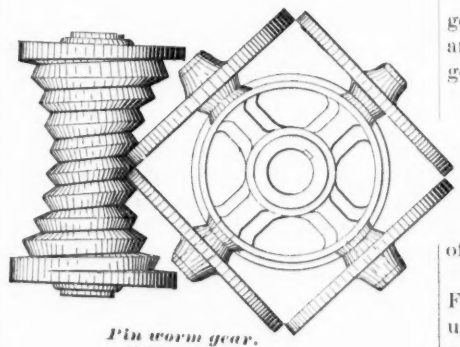
The length of the worm need be no more than three times the circular pitch, for there are seldom more than two teeth in contact at once. If, however, the worm is made long, it can be shifted when it becomes worn, so as to bring fresh teeth into working position. This provision is wise, for the reason that the worm is always worn more than the gear.

122.—THE HINDLEY WORM AND GEAR.

If the cutting hob and the worm is shaped by the tool *a*, and the process indicated by Fig. 102, the resulting pair of gears is known as the Hindley worm and gear. The worm is often called the "hour-glass" worm.

It is commonly but erroneously stated that this worm fits and fills its gear on the axial section, the section that is made by a plane through the axis of the worm and normal to the axis of the gear. It has even been stated that the contact is between surfaces, the worm filling the whole gear tooth.

The real contact is not yet certain, but it is certain that it is not a surface contact. It is also certain that it is on the normal and not on the axial section, and that the Hindley worm hob will not cut a tooth that will fill any section of it. The contact may be linear, along some line of no great length, but it is


Pin worm gear.
Fig. 103.

probably a point contact on the normal section. The order of the contact is certainly very close, resembling that of two surfaces.

The worm is limited in length, for the sides of the teeth cannot slant inward from the normal to the axis. The end tooth *m* in Fig. 102 cannot be used, for it will destroy the teeth of the gear as it is fed towards this axis in the operation of hobbing.

It has the one great defect that it is not adjustable in any direction, and, therefore, cannot change its position when the shaft bearings wear, unless it is itself worn the same amount. It is doubtful if this form of gearing has any advantage over the plain spiral gearing, except when new and in perfect adjustment.

123.—THE PIN WORM AND GEAR.

If the hob and the worm are shaped by the pin-shaped revolving milling tool *b* of Fig. 102, the gearing produced will have linear bearing between the teeth.

The action will be the same as between a series of pin teeth like the milling tool, each pin being in the axial section of the worm, but having a linear bearing on the normal section of its teeth.

This form of gearing, which is a modification of the Hindley form, may take the shape of pin gearing, the teeth being round pins like the milling tool. If the pins are mounted on studs, so as to revolve, a roller pin worm gear will be produced. Fig. 103 shows a form of roller pin gearing in which the pins have been enlarged.

124.—THE WHITWORTH HOBBING MACHINE.

When the amount of work to be done will warrant the use of a special machine, the hobbing machine of Sir Joseph Whitworth may be used. It was invented in 1835, and has not been materially improved since then,

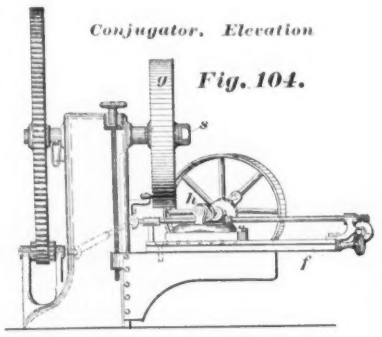
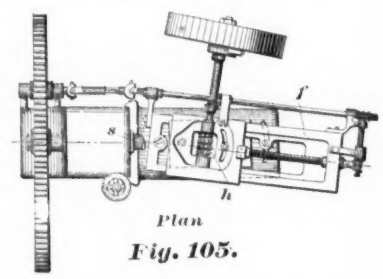


Fig. 104.



Plan
Fig. 105.

although there are numerous patents relating to it. The worm gear to be hobbed is fixed upon the same spindle with a master worm-wheel. A driving worm runs in the master wheel, and it is connected by a train of gearing with a hob that is so mounted on a carriage that it can be fed towards the gear blank. The hob is slowly forced into the blank, while both are revolving with the proper speeds, and the gear is cut without the assistance of previously made nicks. See British patent 6,850 of 1835.

125.—THE CONJUGATOR.

This is a machine for cutting spur or spiral gears by means of a hob, and its principle is an extension of that of the Whitworth worm gear hobbing machine.

If, when the hob in the Whitworth machine has reached the full depth of the tooth, it receives a new motion in the direction of the tangent to its pitch spiral, it will continue the tooth to the edge of the gear, and form the plain spiral gear of Fig. 91.

Fig. 104 is an elevation of the machine, and Fig. 105 is a plan. The hob *h* is mounted upon an arbor that is connected by a train of gearing with the spindle *s* that carries the blank gear *g* to be cut, so that the hob and blank revolve together with any definite proportionate speed. The hob is carried upon a carriage that is fed on a frame *f*. The hob swivels upon the carriage, so that the tangent to its pitch spiral can be set parallel with the direction of the feed, and the frame swivels so that the tooth can be cut at any angle with the gear spindle.

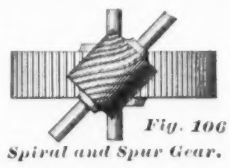


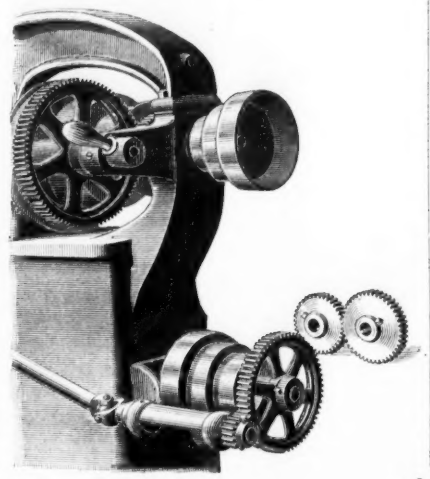
Fig. 106
Spiral and Spur Gear.

As the blank and the hob are revolving, the latter is fed into the former, and it will cut a perfect tooth in the direction that the frame is set at. As the frame can be set in any direction, the machine will cut the common straight tooth. All gears cut by the same cutter will run together interchangeably, and if two gears are cut at the same angle in opposite directions, they will run together on parallel shafts. See U. S. patent number 405,030, June 11th, 1889.

The Board of Trade, of Waterbury, Conn., has issued an attractive pamphlet, setting forth, by illustrations and texts, the advantages of Waterbury as a place of residence and as a manufacturing town. That it has advantages in these directions, we think few will be disposed to doubt, after looking through the book.

Small Screw Machine on Column—Milling Machine Feeds.

The Garvin Machine Co. are now mounting their smaller sizes of screw machines upon columns, as shown by the cut on this page, and can supply them either on legs as before, or on the column, as may be preferred. Of course, the working parts of the machine are unchanged, and it has all the features of the regular screw machine, including wire feed, automatic revolving turret, etc. For the smaller sizes, when used on certain kinds of work, as, for instance, very small and short screws, the column is thought to be preferable to legs, as it is neat and substantial, and is less in the way of the operator when seated on a stool, as is usually the case on such work. In this machine a chuck is used, in which there is absolutely no end motion while gripping the work, and the greatest possible accuracy and uniformity are secured in the length of the pieces cut off.



With the systematic and growing use of the milling machine, the question of feed becomes a matter of prime importance. As to what constitutes a proper rate of feed no absolute rule can be given, since the matter is determined by the mutual relations of cutter and work. To get the greatest return from a cutter, the work should be fed at such a rate that each individual cutting edge shall do its utmost, having due regard to the life of the cutter. This means that the feed per revolution should be increased with large cutters, since a large cutter has more teeth among which to distribute the work. With small cutters the conditions are reversed. Just here is one of the weak points of the average milling machine. Feeds are provided that are about right for the ordinary sized mill, but when a cutter six or eight inches and more in diameter is put on, there is no provision for a proportionate increase in feed, and thus the more expensive cutters, since they must be driven slower, really turn out less work than smaller and cheaper ones.

For very small butt mills, hard stock, extra heavy cuts, etc., the feeds available are too coarse, and, in consequence, the work has to be fed by hand or a special pulley put on. To meet this difficulty, The Garvin Machine Co., Laight and Canal streets, New York City, have lately provided change gears on the feed pulley bracket, as shown, which they are applying to their larger size machines, both universal and plain.

These gears can be changed about, and in connection with the three-step cone give a choice of twelve feeds, ranging from $\frac{1}{48}$ inch to $\frac{1}{4}$ inch per revolution, and thus make it possible to approximate closer to the ideal feed. A view of a portion of a milling machine is given, showing the arrangement of gears.

Notes on Machine Design.

By D. C. WOODWARD.

LATHE BED.

Of all the machine work done in the manufacture of other machines, by far the larger part is now done in the lathe, and this proportion is likely to increase rather than diminish, as designers educate themselves to consider more fully the manufacturing costs. Much has already been written upon lathe construction, methods of doing work in the lathe, and its relation to cost in manufacturing, yet, taking into account the rapid and radical improvements taking place in it at present, and its increasing importance, it is worthy of still further consideration.

As the generic term "lathe" includes engine, chucking and turret lathes, and screw machines, much of that which may be said of one of these applies with nearly equal force to all of the others.

In studying the different styles and makes of lathes in common use, one cannot help wondering that so little thought, apparently, has been given to their design, each maker seeming to have been content to follow in the footsteps of his illustrious predecessor, copying not only the good points in his production, but too often his bad ones as well. Undoubtedly this is largely due to the fact that many of the manufacturers have not given the drawing-room the prominence it deserves, and are working with very few or no drawings, and continue to use old patterns just as long as they will hold together. There are some concerns, however, which cannot offer this poor excuse. They are those new ones which have started up within a few years, going out from old-established firms, and copying nearly every detail in the machines built by the old concern. Worst of all are those who, already in business, have stolen bodily the designs of their competitors without trying to improve them at all. The time has come when the drawing-room must do its share of the work, and old patterns must give place to new, whenever necessary for advancement; but when the time will come that men will not appropriate other designs *in toto*, without giving credit, one cannot say.

Three things are essential in a perfect lathe, or better, perhaps, in the lathe of the future: First, that it shall produce accurate work, and finish an amount greatly in excess of what can be done with any of those in common use; second, that it shall be easy to manipulate—"conform," as some one has said, "to the anatomy of man"—and not be liable to frequent repairs; and last, that the parts shall be so shaped that they may be manufactured by the most improved and best methods, for the cost is an important item.

Generally the size of a lathe is designated by the amount it will swing over the ways; but the superintendent of a certain establishment where a new type of lathe is being brought out, very aptly said, "You cannot measure the size with a two-foot rule."

Lathes of a given capacity should not be allowed to swing over that amount. This rule, however, is violated in two different ways: First, a lathe that is built heavy enough to turn only 16″ in diameter has the head-stock so high that it will swing 24″ in diameter over the ways; and second, this same lathe has blocks placed under the head-stock and tail-stock so that it will swing 30″ or even 36″. Casting the head-stock and bed in one piece will prevent this too common practice of using blocks, and will also add very much to the rigidity of the machine.

Within a year there appeared in the AMERICAN MACHINIST quite a long description of a 16″ lathe. Not only is the head-stock of this lathe cast separate from the bed, but one of the claims made for its superiority is that the head-stock is swung about a center when boring tapers. It is bad enough to have the head-stock cast separate and bolted as firmly to the bed as possible; but to have it movable, and use it for a taper attachment, is infinitely worse, and, to my mind, detracts much from its value for use, either in manufacturing or for the tool-room.

Many of the difficulties encountered in the use of the lathe are due to the poor design of the bed and its supports. The bed is not rigid enough under heavy cuts, and although strong enough to support a dead load ten or twenty times as heavy as any piece that would ever be placed in it, it is continually subject to a change in alignment when resting on the average shop floor.

At present, as well as in the past, makers of lathes are not putting enough metal into the beds; although one might be mentioned, who is using nearly enough in weight, but the material is so poorly distributed that the best result is not obtained.

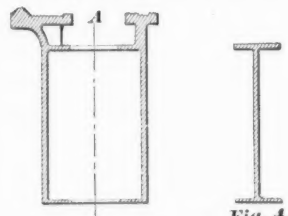


Fig. 3.

Fig. 4.
Section on A-A.

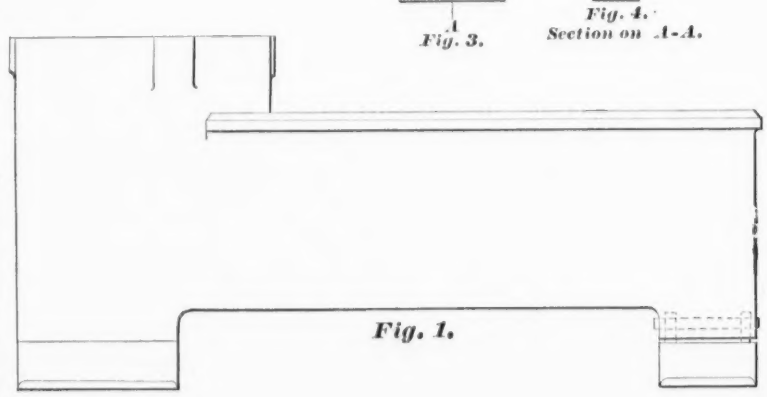


Fig. 1.

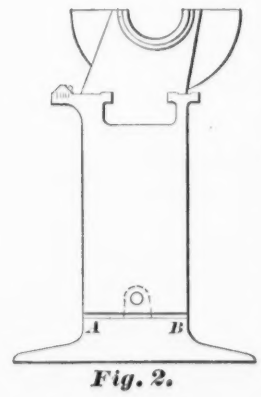


Fig. 2.

Only a few years ago the style was to make the bed with as many curves as would be found in picture-frame moulding, but this has given place almost entirely to a simpler and much better form, which is nearly like two I beams placed side by side, and tied together with cross-ribs. The strength and stiffness of this construction depends upon the depth of the sides and the manner in which they are tied together. For a vertical load, the strength is proportional to the square of the depth. To illustrate, take a 21″ lathe bed, the depth of which does not average over 12″. If it is made 24″ deep the weight is doubled, but it is four times as strong. To resist the torsional strains, the cross-ribs should be much nearer together than is usual, but they need be no thicker than the sides, and should extend from as near the top as possible to the bottom of the sides. These ribs should have a section as shown in Fig. 4, and with the section shown in Fig. 3 would make nearly a box form, which is the most desirable.

Several writers on lathe construction have advocated a tripod base for a lathe. [First proposed by Prof. John E. Sweet.—Ed.]. Although but one or two makers support their lathes on three points, it certainly is the correct way, and, moreover, there is not a lathe made that can be relied upon to remain in accurate alignment, if supported at four or more points when placed upon a foundation that is subject to change.

Three points of support may be obtained by bolting the leg under the head-stock to the bed as shown in Figs. 1 and 2, while the other end is supported on the trunnion *C*, which has its axis parallel to the center line of the spindle.

To show clearly the necessity of a tripod support, an incident which happened in the construction of a 21″ lathe, recently built, will suffice. The machine had a 12-foot bed, similar to Fig. 1, the sides of which were $\frac{3}{4}$″ thick at the top, tapering to $\frac{1}{2}$″ thick at the bottom, and 29″ deep. The cross-ties or ribs (Fig. 4) were $\frac{1}{2}$″ thick, extending from within four inches of the top to the bottom of the sides, and were 12″ apart from center to center. This lathe also differed from the general style of construction in that it had no V guides for the carriage and tail-stock, but had a flat top, which was to be scraped to a surface plate. The bed was supported as in Fig. 1, but there was so little clearance between the leg and bed at the points *A* and *B*, that, when erecting, the action of the trunnion was overcome by one side of the leg being lifted too high through carelessness, and it resulted in four points of support instead of three. The workman in using the surface plate experienced much difficulty in obtaining a perfect surface. Upon investigation the difficulty was found to be caused by the four points of support, and although the bed alone weighed 3,700 pounds, and is probably four times as stiff as any 21″ lathe in the United States, it showed a very noticeable deflection. If such a bed as this will spring from the weight of a surface plate added to its own weight, what may be reasonably expected from the ordinary lathe, with its four points of support resting upon a floor that changes with every varying load placed upon it?

If a lathe could be placed upon a never-changing foundation, rigidly bolted to it, and then finished in position, four points of support might be as good as three; but unfortunately this condition is seldom found.

The supporting and guiding surfaces for the carriage and tail-stock are very important features in a lathe, and it will be well, for several good reasons, to reject the common practice of using four narrow Vs. First, it is difficult in manufacturing to produce accurate alignment; second, the surfaces are so small that they wear away rapidly, and third, the angle is so acute that the change in

alignment, due to a given amount of wear, is greater than the wear itself.

A flat top is much better than the four narrow **V**s, but a much better form than either is a flat top, with a single **V** on the front to guide the carriage, as seen in Fig. 2. This **V** should be very broad, and the angle not less than 100°, so that the change due to the wear may be reduced to a small amount. If good planer work is done on these surfaces it will cost very little to obtain accurate alignment, and the surfaces will wear much longer than the narrow **V**s.

Force, Motion and Work.

BY PEDRO.

FIFTEENTH PAPER.

RESISTANCE TO MOTION.

Resistance is a term applied to the force or any cause which opposes any body in its motion. Thus far we have studied force and motion under the supposition that all bodies of matter are perfectly free to move when urged to do so; that there is no resistance to being set in motion. But the fact is that there is no such thing in nature. To impart motion to a body we must first of all overcome resistance. A falling body is resisted by the atmosphere, and its motion is reduced in proportion to the resistance. The motion of a train is resisted by the atmosphere, and the friction of the various pieces of moving machinery. We know of nothing in nature which can be set in motion without having first overcome some resistance.

Again, in the previous discussions we have, for convenience, considered only *one body*, while the fact is that there are always two or more bodies involved in the motion of matter. A body cannot be set in motion without force; there can be no force unless there is a second body to produce that force. The first may be called the *passive body* or the passive agent, while the second is conveniently called the *active body* or the *active agent*. In machinery the first is usually called the *driven*, and the second the *driving body*, or simply the *driver* and the *driven*. In a steam engine the piston is the passive, and the steam the active agent. A horse is an active agent, and a vehicle drawn by it is the passive body, etc.

We may accept the fact, then, as a universal law, that all bodies offer resistance to being set in motion, and that no body will start to move until all the resistance is overcome by the active agent. But how can we measure the resistance in any given case? The third law of motion (tenth paper) will help us to answer this question. According to that law the mutual actions between two bodies are always equal and in opposite directions; hence, if a force be applied to a body, and it be gradually increased until the body starts to move, then the force thus applied is the exact measure of the resistance according to the third law of motion.

Resistances to motion may be classified under two main heads; first, *inertia resistance*, being that force required to overcome the inertia of a body. In the twelfth paper we have seen that it requires a force equal to $\frac{w\ a}{g}$ to set a free body in motion with an acceleration equal to a. This fact, then, shows that, although there may be no external resistance, there is a resistance, according to the third law of motion, which is inherent in the body itself—a reaction equal to action. According to the property called inertia a body has no power to "change its state of rest or of motion," but does seem to have the power to *resist* such a change. The force required to overcome this resistance is called the *inertia resistance* of the body, and is therefore represented by Equation 46, twelfth paper. As this equation is simply a static force on the one side, which is equal to a dynamic force generated in the unit of time on the other side, we see that the amount of static force (f) required to *overcome the inertia resistance* of a body is measured by the dynamic force generated in the unit of time.

Again, if a body has been set in motion with a velocity V in any given time t, and it meets with a resisting force which can bring the body to rest in a unit of time, then the velocity, V, will be the retardation of the body, according to Equation 27 (VI.), fifth paper. Hence, by Equation 46, twelfth paper, the force required to stop the body, in the unit of time, is $\frac{w\ V}{g}$. This, we see by Equation 48, is the dynamic force generated in the time t by the static force which produced the motion. This leads to the following definitions:

Dynamic force represents the resistance which a moving body is capable of overcoming during the unit of time with its average speed. In other words, it is the amount of static force stored in a body at the stated time.

Accelerating force (which is the dynamic force generated in the unit of time) *represents the amount of the static force required to move a body with the stated acceleration.*

Example.—A ball weighing 20 pounds is acted upon by a static force of 10 pounds for a time of ten minutes. By Equation 49 the acceleration is

$$a = \frac{10 \times 115776}{20} = 57888. \text{ feet a minute.}$$

By Equation 48 (II.) the dynamic force is

$$F = 10 \times 10 = 100 \text{ lbs.}$$

This illustrates the appropriateness of the terms *static force* and *dynamic force*, as there is a marked difference in quantity, which difference depends upon the time of action of the static force. Also, this force is "dynamic" because it depends upon the motion of the body, and it is a "force" because it is a measure of the *resistance* (force) which the body is capable of overcoming at the average speed with which it is moving, that is, the static force of 10 pounds acting upon any body ten minutes imparts to that body the power of overcoming a resisting force of 100 pounds, with an average speed equal to the average velocity that the body acquired during the ten minutes of its motion.

The inertia of matter, and the foregoing, lead to the following conclusions, assuming the quantity of matter in the moving body to remain constant during the time of the motion considered.

First.—The amount of the force stored in the body, that is, the dynamic force, is proportional to the time during which the static force acts upon the body.

Second.—As soon as the external influence (static force) ceases to act upon the body, no more force will be stored, and, therefore, the dynamic force will remain constant thenceforth, since the body itself has no power to change its own condition; hence,

Third.—The body will move with a constant velocity (the velocity acquired) until some external influence changes the amount of force stored in the body, since the velocity is the only quantity in the dynamic force (Equation 48, twelfth paper) which can be changed. This is substantially the idea expressed in the first law of motion.

Fourth.—When an opposing force acts upon the body at any time, it will be deprived of some of its dynamic force, and, consequently, its velocity will be reduced or the body will be retarded. If the force acts in the direction of the motion, more force will be added or stored in the body, and, therefore, its velocity will be increased or accelerated in proportion to the additional amount of force stored in the body.

The relation of all the quantities involved in a moving body, uniformly accelerated, is geometrically illustrated in Fig. 49. The triangle $A\ B\ H$ is the motion diagram already explained in previous papers. The triangle $A\ B\ C$ is the force diagram which is similar in appearance to $A\ B\ H$. Any line drawn horizontally at right angles to the base line $A\ B$, and meeting the velocity line $A\ H$, represents the velocity of the body. A line drawn vertically from the same point, and at right angles to the base line $A\ B$, represents the force stored in the body, or the dynamic force generated in the time represented by that point in the base line. Here we see that the force of the body—that stored in it—is accelerated in the same manner as the motion. At one minute's motion we have the acceleration a and the accelerating force f. In a time $t = A\ B$, the body moves with a velocity $B\ H = V = a\ t$, and the dynamic force generated is $B\ C = F = ft$. The gravity line, represented by the heavy lines at $D\ E$, represents that velocity, $D\ E$, of the body which is equal to the acceleration of gravity, g. At this point the force is equal to the weight, w, of the moving body.

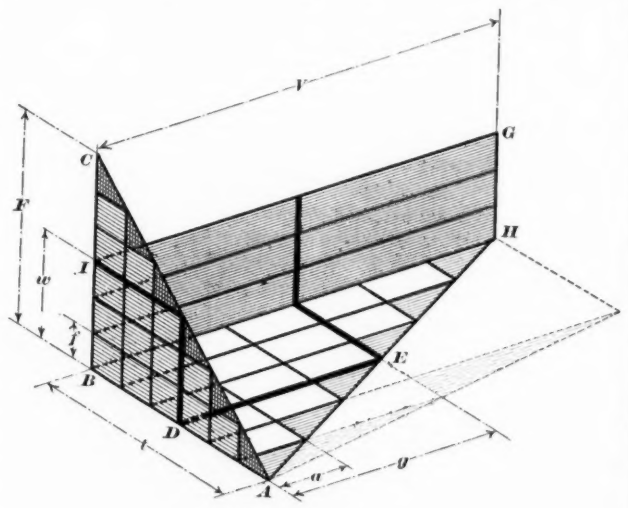


Fig. 49.

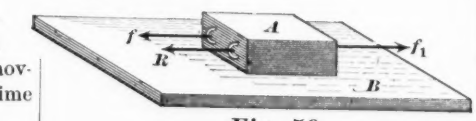


Fig. 50.

Another way of explaining *what* dynamic force is, is simply this, that it is an equivalent weight upon which gravity produces the same effect in the unit of time as the moving body is capable of producing independent of gravity.

In the diagram, Fig. 49, the weight is represented as being 3 pounds; the velocity, V, is two gravity units $\left(\frac{V}{g} = 2,\right)$, therefore the dynamic force, F, is, by Equation 48 (I.), $3 \times 2 = 6$ gravity-pound-minutes, or simply 6 pounds, which is shown by the number of "gravity rectangles" in the rectangle $B\ I\ G\ H$ whose height is the weight, w, of the moving body, and the length is the velocity, V, measured in gravity units for the common system of measuring force, and in absolute units for the absolute measure of force.

The time of motion in the diagram is six minutes; the accelerating force f is one pound, therefore $B\ C = F = 6 \times 1 = 6$ lbs., Equation 48 (II.), as before.

From the triangles $A\ B\ H$ and $A\ D\ E$ we get by proportion

$$\frac{A\ B}{A\ D} = \frac{B\ H}{D\ E} = \frac{V}{g}.$$

Also, from the triangle $A\ B\ C$, we get

$$\frac{A\ B}{A\ D} = \frac{B\ C}{B\ I} = \frac{F}{w}.$$

Combining these two equations we get

$$F = \frac{w\ V}{g}.$$

This is the same as Equation 48 (I.) In a similar manner we can obtain Equation 46 from the diagram, Fig. 49.

The foregoing may be briefly summed up by saying that the inertia resistance of a body is measured by the amount of static force required to set it in motion, and that the resistance which the body is capable of overcoming at any time, at its average speed, is measured by the dynamic force generated in that time.

Under the second division of resistance come all those which do not depend upon inertia, such as friction, wind pressure, etc., and these may be called *physical resistances*, and we will represent the sum of all such resistances opposing the motion of a body by the letter R.

Let A, Fig. 50, be a material body, resting upon a plane surface, B. Let f be the inertia resistance, R the physical resistance, and f_1 the force applied to move the body. While the body is being started we have, according to the third law of motion,

$$53. \ldots\ldots\ldots\ldots\ldots f_1 = R + f.$$

Substituting in this equation the value of f from Equation 46, twelfth paper, we have

$$54. \ldots\ldots\ldots\ldots\ldots f_1 = R + \frac{w\ a}{g}.$$

Rule 54.—The amount of the static force required to set a body in motion is obtained by *adding to the physical resistance the inertia resistance, or the ratio obtained by dividing the product of the weight and the acceleration by the acceleration of gravity.*

Example.—The physical resistance of a body, Fig. 50, is 5 pounds; its weight is 50 pounds, and it is desired to set it in motion with an acceleration of 3,859.2 feet a minute, what is the force required to do this?

By Rule 54

$$f_1 = 5 + \frac{50 \times 3859.2}{115776} = 6\tfrac{6}{8} \text{ lbs.}$$

Now, suppose that we wish to bring the speed up to one mile, or 5,280 feet, a minute, and then have the body move with a uniform speed. With the acceleration of 3,859.2 feet a minute, it will require 1 minute and 22 seconds to attain the speed. (Equation 14 (I.), fourth paper.) If, after this time, the body is to move with a uniform speed, then the force which was applied to overcome the inertia resistance must cease, or in other words, there must be no more acceleration, according to the first law of motion. Hence, if we make a = zero, then Equation 54 reduces to

$$55. \ldots\ldots\ldots\ldots\ldots f_1 = R.$$

Rule 55.—*Hence, to keep a body in uniform motion requires the constant application of a force which is equal to the physical resistance of the body.*

In the previous example the force required to keep the body moving at a uniform speed of one mile a minute, after that speed is attained, is 5 pounds, while it takes $6\frac{6}{8}$ pounds to start it with an acceleration of 3,859.2 feet a minute. We see, then, that it takes more force to start a body than it does to keep it in motion after it is once started, and that the *starting force*, as it may be called, increases with the rapidity with which the body is started. If the body, Fig. 50, is brought to the desired speed with an acceleration of 1,929.6 feet a minute, instead of 3,859.2 feet, then the starting force will be only $5\frac{6}{8}$ pounds instead of $6\frac{6}{8}$ pounds, but it will take just twice as long (2 minutes and 44 seconds) to get up a speed of one mile a minute.

This fact, as represented by Equation 54, can be seen illustrated any day in horse-car travel. We have often seen how intensely the horses exert themselves to start a loaded car, and how easily, comparatively, they draw it after it is started.

Also a railway train, in starting off from a station, is given full steam, but the engineer "hooks her back" (shuts off some steam) as the train gets its speed.

A locomotive, to make good time, must "get away from stations lively," and get up speed in the quickest possible time. To do this it must have a large surplus power to furnish the necessary starting force.

Thus far we have assumed that the physical resistance is constant, but this is not always the case. The physical resistance is made up from various sources. The most common of these are friction, the atmosphere, and gravity.

Friction is the resistance we find in sliding one body upon another. The amount of the force required to slide it is called the frictional resistance of the body, or simply the friction. This has been found by experiment to be a certain fractional part of the total pressure on the sliding surface, and that fraction is called the *co-efficient of friction*. For example, when we say that the co-efficient of friction is $\frac{1}{10}$, we mean that the force required, in the direction of the motion, to slide the body upon another, is one-tenth of the total pressure on the sliding surface.

The co-efficient of friction depends, for its value, upon the material and condition of the sliding surfaces. Tables giving the value of the co-efficient of friction for various substances can be found in various mechanical books. Friction is usually considered to be the same for all ordinary speeds, but is thought to vary somewhat at different speeds. It is also greater at the time of starting than when the body is in motion. This accounts for a part of the extra starting force required in moving a body. For most practical purposes it may be regarded as a constant quantity.

A body in passing through the air, or any other fluid, meets with a certain amount of resistance, in consequence of being obliged to continually displace an amount of the air which is equal to the volume of the body itself (or somewhat more) so as to make room for it as it advances in its motion. There is also a certain amount of friction caused by the body moving through the air. The resistance of the air is usually regarded as increasing about as the square of the velocity of the moving body. Hence, if a body's speed is doubled, the resistance of the air is four times as great as it was at the slower speed. If the speed is increased four times, the resistance is increased sixteen times, etc. At high speeds this source of resistance becomes a serious obstacle to motion, while its amount at slow speeds is very small and may generally be disregarded.

Gravity adds to the physical resistance by creating friction between the bearing parts of machinery, in consequence of the weight of the parts on the bearing or sliding surfaces; also by direct opposition, as when a train is going up grade, or when a body is lifted against gravity.

Generally speaking, then, the total resistance of a body to being set in motion increases with the speed. Hence, if the applied force is constant, there is a time in the motion when the resistance has increased so that it will be equal to the driving force, after which there will be no more acceleration, but the body will move with a uniform speed (Rule 55) since there is no longer a balance of force to be stored in the body. As the resistance gradually increases, the acceleration gradually decreases until it becomes zero. Such a motion is represented by the diagram of Fig. 7, fifth paper. If the driving force is decreased, then the motion of the body will be retarded until the resistance and the driving action are again equal. A railway train is a fair example of all these varying conditions.

From Equation 53 we obtain, by transposing,

$$56. \ldots\ldots\ldots\ldots\ldots\ldots f = f_1 - R.$$

Rule 56.—Hence, we can find the inertia resistance of any body by *subtracting the physical resistance from the actual force required to move it* when these are known.

This is only another way of finding the force required to overcome the inertia of a body from that already found in Equation 46, twelfth paper, and shows that, whatever the resistance of a body may be, the force which overcomes the inertia, or which gives the body motion, is always the unbalanced portion of the opposing actions. For example, if a body weighing 2 pounds is urged to move by a pressure of 10 pounds, and the resistance is 7 pounds, then the unbalanced pressure urging the body to move is 3 pounds, from which we find its acceleration to be 173,664. feet a minute. (Rule 49, twelfth paper.)

We have received from the Superintendent of the Census, Robt. P. Porter, Census Bulletin No. 8, which gives information regarding the slate industry. Under the heading of Labor and Wages, it gives the average wages, for the entire country, paid to foremen and overseers, $2.48 per day; for quarrymen and millmen, $1.56; for mechanics, $1.64; for laborers, $1.27, and for boys, $0.76. We don't know just what kind of mechanics are referred to, but it will be conceded that their remuneration can scarcely be called munificent. In Pennsylvania they receive $1.54 per day, while laborers in the same locality get $1.40.

LETTERS FROM PRACTICAL MEN.

Editor American Machinist:

In your issue of July 21st, I find an article under the heading, "The Highest Rotative Speed," which recalls to mind a term of most interesting idleness I was compelled to spend in the territory of Idaho in 1883, while waiting for mining machinery snow-blockaded on the Union Pacific R. R. I had about two months of waiting to do, and was put to my wits for means to render the time endurably occupied.

Fortunately, I had some machinery on the ground, including a No. 5 Barnes lathe, and a 2 H. P. portable engine, together with odds and ends of tools and scrap stock previously freighted out there.

The whimsical notion seized me to reach the highest limit of rotative speed, if I could. I did not reach it, but I got pretty well on the way, as you will see by noticing the following *six figures;* to wit, 537,600 revolutions per minute.

How was it done, and how accurately counted?

I was aware that physicists had employed rotating mirrors to determine the rate of travel of a beam of light, but I did not aspire to enter that field of investigation at the time. I merely pursued the trifling fancy for want of more profitable means to render the suspense endurable.

The construction of my apparatus was as follows (I think your readers will understand without diagrams): I made a worm-wheel of hard bronze, about $3\frac{1}{2}''$ diameter, and having 32 teeth. This I caused to engage with and drive a hardened steel worm $\frac{7}{16}$ iameter. Upon the worm shaft I mounted another wheel made of hard sheet brass, about $3\frac{1}{2}''$ diameter, having 84 teeth.

This wheel I caused to engage with and drive a worm $\frac{1}{16}''$ diameter by $\frac{1}{4}''$ long. This worm was made of Stub's steel, hardened and carefully ground. It was mounted in hardened bearings, and in such a manner, that a stream of oil could pour upon its entire working surface during the operation.

Now, if your readers will follow the figures, they will notice that the little worm was in the same condition that the Irish bride thought the waters of Niagara were. "It could not help running as it did."

The first wheel was run from the little steam engine, and made 200 revolutions per minute. First worm made 200 × 32 = 6,400; multiply this by 84 (number of teeth in second wheel), and the result gives speed of second worm. It is but fair to state that the teeth of the second wheel lasted under full speed only 4 minutes.

I intended at the time to send you an account of the matter, but concluded to delay until I could get leisure to make another test with improved apparatus.

I believed then, and I do now, that a well-constructed apparatus, consisting of two wheels and two worms, will drive a small free spindle, one million turns in one minute.

Chicago. C. C. HILL, M. E.

A Crank-pin.

Editor American Machinist:

I have been a reader of yours and other mechanical papers for the last twelve years, and in that time I don't remember reading anything about crank-pins or crank-pin brasses that will equal what I am about to state, viz., that James Ford, chief engineer of the Syracuse electric light and power station, has run their No. 1 engine (a Reynolds Corliss 26″x48″) since July 5th, 1888, up to date, without touching crank-pin key, a little over two years. During that time the engine has been run almost constantly, never being shut down over seven or eight hours at a time, and has developed as high as 525 H. P.

Inclosed you will find a card taken from this engine July 29, 1890, indicating 361.70 at 9 P. M. At 1 o'clock her load is increased to nearly 500 H. P. until daylight.

I visited Mr. Ford to-night and found the engine running as quietly as possible.

If anybody can beat the record of James Ford on this engine, I should like to hear from him.

Thinking that the above may be of interest to some of your readers, I remain,

W. H. ACKER.

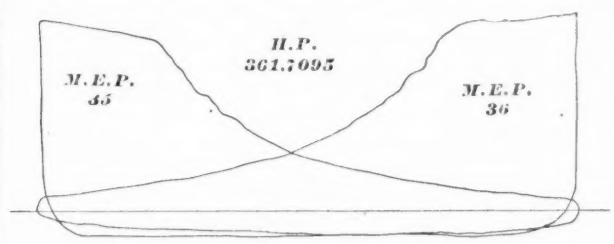
That Cupola Explosion.

Editor American Machinist:

An accident to a foundry cupola, somewhat similar to the one referred to in your issue of July 31st, which occurred some years since, at an establishment of which I was at the time superintendent, leads me to believe that the cause of explosion might have been discovered, had a sufficiently careful examination of all the debris been made.

The accident to which I refer was not so disastrous nor so fatal as the one you record, although somewhat similar, and quite costly in the item of repairs.

The cupola, if my memory serves me right, was very nearly same size and arrangement as the New York one. The blast had been on for an hour and a half, and the iron had begun to melt, but cupola had not been tapped, when a report sounding like discharge of cannon was heard, and the bottom of cupola was blown out, the wind-box and pipes destroyed, and the iron, melted and partly melted, was scattered very generally.



The next morning I made a very thorough examination, believing that there was a reasonable prospect of ascertaining the cause. I questioned closely as to character of scrap used, and after a while I found the pieces of a hollow piston, which had been thrown into cupola whole. This piston was for 12″ cylinder, and the three or four core-holes had been plugged, and then it had been rejected for some reason, and had been condemned and thrown into scrap heap; not being very heavy, the melter had thrown it into the cupola whole, not thinking that the confined air might become heated, and cause an explosion, which undoubtedly was the sole cause of our accident.

As I had known of a fatal accident by the bursting of just a piston being heated in a blacksmith forge, not long before that, I concluded, I believe rightly, that the explosion in our cupola was from the same cause, viz., confined air heated to a very great temperature, and gave orders that no hollow castings should ever be put into cupola without being broken, so that there should be no possibility of air being confined.

The supposition that this reported explosion may have been produced by similar means, may seem inadequate, but I should not be surprised if the true cause was something of that nature. C. C. COLLINS.

Newark, N. J.

Editor American Machinist:

I will try and show cause why the cupola at Cassidy & Adler's foundry exploded.

In the first place, the cast-iron that the cupola was made of was very sorry iron, and in the second place, the iron was too thin. It should have been $\frac{3}{4}$ thick at bottom, where the wind-belt was, and continue for about 10 feet, then from that point to top of stack could have been of $\frac{5}{8}$ iron.

I would like to know if the cupola had a pressure gauge on to indicate how great the pressure was at the time of the explosion. There should not have been over 8 ounces pressure on a cast-iron cupola only $\frac{1}{4}$-inch thick.

This is the second cupola that I have known to explode. The first one was caused by using all fine scrap-iron, which caused the cupola to crust over, and the wind could not escape. No foundryman should use a blower unless he knows how much pressure it is giving the cupola, as a blower is a positive blast machine, while a fan is not. I am satisfied if the cupola had been of heavier iron, there would have been no explosion.

P. C. J.

[The shell of the cupola referred to was of wrought-iron plate; not of cast-iron, as our correspondent seems to infer.]

Shaft Governors.

Editor American Machinist:

Mr. Begtrup's article, published in the AMERICAN MACHINIST of July 31, seems to me open to discussion as to one or two points, although in the main I agree with him and accept his conclusions. Mr. Begtrup twice speaks of the resistance of a dash-pot increasing as the square of the velocity. I am aware that this is the usually accepted theory among engine builders, but is it correct? A certain pressure on the piston of a dash-pot will give a corresponding velocity to the liquid passing through the small hole. Now doubling the pressure will give twice the velocity to the jet, and so permit a movement twice as rapid. If this is true, the dash-pot resistance should vary directly as the velocity. In the governor under discussion (the straight line), the fly-weight does not move radially, and Mr. Begtrup has assumed that one effect of this is to lessen the stability of the governor. Under the peculiar conditions I do not think it can be so considered. The amount of the fly-weight's radial movement, and the centrifugal force, "in proportion to the mass or weight of the ball and other moving parts," are not necessarily changed by giving the fly-weight an other than radial direction of movement, while its longer travel gives it greater inertia to overcome valve resistance. Although this extra movement of the fly-weight might tend to make the governor tardy, it is hard to see how it could decrease stability, and tardiness has never troubled the governor in question. As to the second reason given by Mr. Begtrup why stability is affected by this arrangement. Upon the acceleration or returned action of the fly-wheel, the inertia of the fly-weight has an actual tendency to move it in the opposite direction from that in which it should and does go, and so acts to make the governor tardy, but not as Mr. Begtrup claims, to destroy stability. This effect is, as Mr. Begtrup remarks, very slight where heavy fly-wheels are used, and, I may add, when the speed is high, for the reason that, in the first instance, the acceleration will be less, and, in the second, the power of the governor to overcome the resistance will be increased. The most effective angle for the path of the fly-weight is hard to locate theoretically; there are so many things governing it which we cannot know: it certainly is not a constant angle under differing conditions; a slow speed and light fly-wheel might restrict the line of motion to a small angle with a radial line, while a high speed and heavy fly-wheel might permit a very considerable angle. The effect of governor friction is very different from that of valve friction and inertia; the valve resistance can only be overcome by the inertia of the governor, and with a reasonably heavy governor and balanced valve seldom has a bad effect. It serves to keep up a slight vibratory action in the governor, and so make useful the governor friction which then tends to preserve stability, permitting a slow movement of the fly-weight, but opposing a more rapid motion. The fly-wheel governor will work all right under a great many conditions, and in a great many forms. A gentleman, whose name I do not recall, related at the Cincinnati meeting during the governor discussion an anecdote which was very much to the point. A gentleman who had made an experimental telephone in the early days of that invention, was relating his experience with it to Mr. Brush, and said that, to his astonishment, the thing worked. Mr. Brush remarked: "If you had told me you made a telephone, and that it wouldn't work, I should have been very much surprised." But although a designed poorly governor

may work fairly well, the best results can only be obtained by careful study of the principles involved, and this applies to the designing of machines for any purpose whatever. A successful design, whether of a fly-wheel governor or a railroad spike, is simply a lot of shrewdly-made compromises. It is very hard in designing to see all the factors in the case, and doubly hard to give them, for bad or good, their proper weight, so that, in adjusting these compromises, we often make bad bargains, and give more or get less than we think. It is often the case that the little catch which we were so very sharp to foresee and avoid proves of no consequence after all, while some point we thought insignificant, or overlooked entirely, makes no end of trouble.

E. J. Armstrong.

A "Kink" in Hand-saws.

Editor American Machinist:

The sketch represents a shop wrinkle which is not generally known, and which will be appreciated by every one who uses an ordinary hand-saw. These saws are usually hung up by the handle, involving a very awkward operation every time they are taken for use or replaced on the pin. It usually requires both hands to go through this performance, so common to every woodworker that its awkwardness is not appreciated, and will not be until he has his saws intelligently hung up by the point, with the handle within reach. Then he will wonder why he didn't have that hole drilled in the point long ago. By the way, drilling that hole is the only difficulty in the matter, but any machinist knows how to drill a saw of ordinary temper. Don't be contented with a small hole, but make it $\frac{5}{8}$" or $\frac{3}{4}$", although the machinist will doubtless drill a small hole first.

When you have your saws thus properly suspended, you will hang them up a dozen times a day where you now lay them down for a few minutes until you want them again.

Besides, this method has decided advantages to the saw itself. Its handle is not scratched and marred by being constantly placed and replaced on a rough nail or screw, and its blade is not corroded by the sweaty hands of the workman, as is necessarily the case in the old way.

So far as I know this improvement in saws is the invention of a wheelwright in Mendham, N. J., whose name I have forgotten. But it has not been patented, and is public property.

It would be a decided boon to wood workmen if saw makers could be induced to put this hole in the saws when they are made, and the writer hopes that the publication of this may tend to that result.

Hackettstown, N. J. J. C. Green.

Thick and Thin Boiler Plates—Water Circulation.

Editor American Machinist:

Your highly esteemed and instructive correspondent, Mr. W. H. Booth, in discussing the merits of thin and thick boiler plates situated where liable to become over-heated, says the cause of plates burning is the "want of quenching contact on one side. Foam is not a good quencher, so plates burn when exposed to foam and not to water." What he means by foam, I presume, is the mixture of steam and water that makes up the current in a generator, and is more or less dense, according to the rapidity of generation, and not the froth that only exists at the surface of a boiling fluid.

I dissent somewhat from this explanation. Let us consider the operation of a tubulous boiler under forced draught, as used in torpedo boats, where all of the enormous amount of steam they generate, together with the circulating water, passes through hundreds of small tubes on its way to the separator; this mixture must be in a condition of foam of little density, and yet, so far as I am informed, no trouble is experienced from burned tubes.

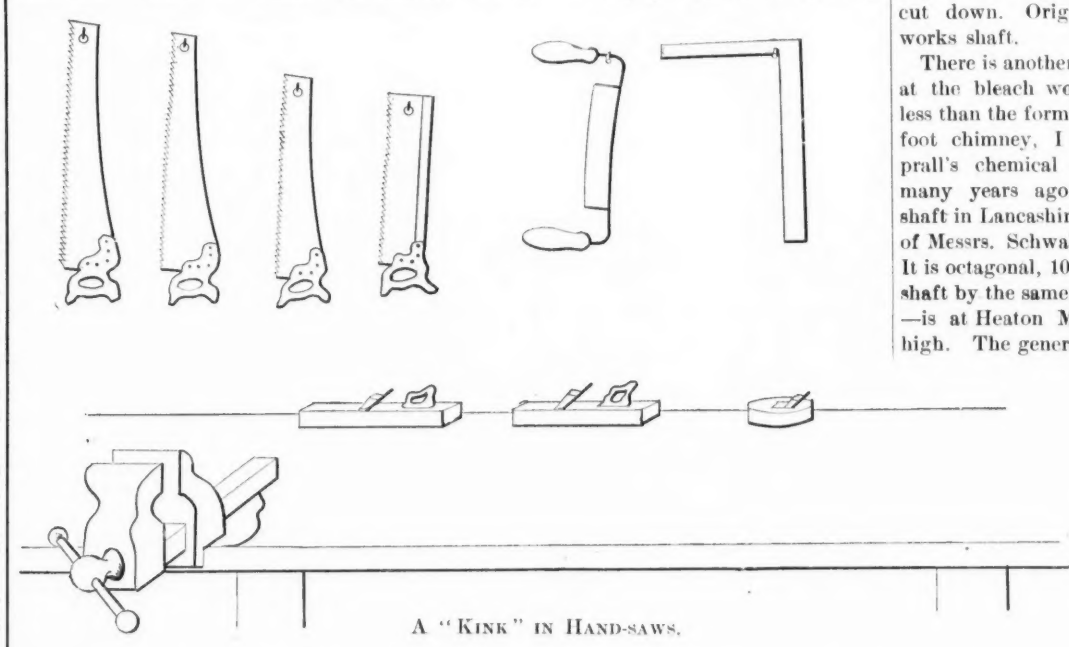
It is not so much the density, as it is the quantity that contacts with the heated plates, that is most effective in keeping down their temperature.

To insure a large quantity of the fluid or mixture to contact with the heating plates, an adequate velocity of the upward and downward currents must be obtained, and this velocity can only be obtained, in natural circulation, by having the paths of the currents as short and direct as possible, because the force producing the currents is a definite one, depending on the excess of weight of the water above that of the steam generated. The velocity of the currents is reduced where there is interference, and when the steam is hampered in escaping.

I have seen the coils of a generator, where the steam had to travel through a long distance before escaping, become over-heated, although they were under more than four feet head of water. A coil boiler having extensive use cannot be operated without forced circulation.

If a plate of ordinary thickness receives heat sufficient to evaporate one pound of water in a certain time, and provision is made for the escape of only half of this amount, the plate is liable to become over-heated, but if there is ample allowance for the steam to escape, it will not over-heat.

There is no difficulty of the water finding contact with the heating surface wherever the steam leaves it, and where there is no interference of currents. With a blow-pipe flame, and an open pan of water, I have failed to over-heat the metal, although the contents were got into an attenuated foamy condition. From the nature of the conditions that obtain in steam generation, where there is the greatest velocity of the circulating currents, there is the most foam, and the greatest amount of heat extracted from the plates.



A "Kink" in Hand-saws.

Of course, where two currents have the same velocity and other like conditions, the denser is capable of extracting the most heat from the plates, and here appears the matter of pressure as a factor, in preventing the over-heating of boiler plates. In the same generator there is little difference in the "head," whether the steam is generated under 25 or 100 pounds pressure, because, while the steam becomes heavier at the higher pressure, the water at the same time becomes lighter. Practically, the velocity of the currents may be assumed to be the same. The volume of the steam is much less at the higher than the lower pressure, consequently the density of the circulating current will be greater, and its capacity for extracting heat also greater.

As to the desirability of using purified water, and leaving the scale outside instead of inside of the boiler, I fully agree, and I am happy to see engineering practice tending in that direction. C.

Gearing.

Editor American Machinist:

In the eleventh paper of Mr. Grant's excellent series on gearing, he states that the sliding velocity of cast-iron worms should not exceed two hundred feet per minute, and adds, that the efficiency would probably be higher for steel worms and bronze wheels. This is correct, and has been frequently demonstrated. Some years ago we made a heavy milling machine driven by screw gearing. The worm was $1\frac{1}{2}$ inch pitch, and 6 inches pitch diameter, the wheel 24 teeth, both well made of cast-iron. Owing to a change of service, for which the machine was not designed, it became necessary to run this worm 500 revolutions per minute; the pressure on tooth surfaces was also severe. It is needless to say, that, despite every effort to maintain the gear, heating and cutting and speedy destruction ensued. The worm was then made of steel and hardened; the wheel was made of phosphor bronze.

This gearing, with a rubbing velocity of about seven hundred and fifty feet per minute, has been in continuous service for three years.

The example shows what is possible, rather than desirable to follow. It is well to remember that for service similar to the foregoing instance, that the very soft low tension steel is not a good material. It has a decided tendency to cut, and has proved of doubtful utility for heavy mill spur gearing.

For cast gearing, it is probable that steel of about 80,000 pounds tensile strength, will prove best, although we have not sufficient data on the subject to form positive conclusions.

It is understood that the railroad companies find that the very soft steel does not give satisfactory wearing surface for the journals of car axles.

As steel is largely used now instead of cast-iron for toothed gearing, it is desirable to know what stress it may be safely exposed to. The following rule has been found applicable, for steel castings having a tensile strength of 70,000 pounds or over, per square inch.

$6{,}000 \times \text{pitch} \times \text{face for plain teeth}$
$9{,}000 \times \text{pitch} \times \text{face for shrouded teeth}$
} equals the destructive stress acting on the face of the teeth.

Loads in pounds; dimensions in inches.

For working pressures use from $\frac{1}{4}$ to $\frac{1}{5}$ of the above, according to the conditions of the service. Of course, rules of this character must be used with discretion, as if applied to teeth of very large pitch, a limit is reached when the pressure per unit of area in contact becomes excessive, and the teeth would be destroyed by crushing of their bearing surfaces, before they would bend or break. James Christie.

Pencoyd, Pa.

"Haste Makes Waste."

Editor American Machinist:

I should like to emphasize the thought brought out by Jarno, in your issue of Aug. 7th. It is an old adage that "haste makes waste," and it seems to me that we find it very often exemplified in the machine shop.

It is not necessary to tell the thoughtful man to make haste slowly, it is the man that is always blundering along, and is never exactly successful, that needs admonishing.

I am acquainted with a man that holds the position of master mechanic in a large mill, who will take some pains in laying out work, and then (if it is drilling for instance), with hammer and center punch, the blundering commences. He will put his center anywhere it happens, and drill it in the same careless manner, then comes the chipping and filing, and the fretting and stewing. The same man will scarcely ever drill a dozen holes without burning his drill.

The other day in the shop there was a man running the shaper, one of your hurry-up get-there men; his belt came off over the large end of cone, in such a manner that it was difficult to get it back, and after fussing away some ten or fifteen minutes, piling boxes, etc., to stand on, another man stepped up, slipped the belt from the lower cone, and it took but a moment to do the rest.

These are simple illustrations, but such as may be seen any day in some of our shops, and, it seems to me, the chief reason why one man does the most of his work right, and another man never does anything right.

Syracuse, N. Y. E. O. S.

English Smoke Stacks.

Editor American Machinist:

C. W., of N. J., asks in your columns concerning the highest smoke stacks in Lancashire.

I believe the highest is that of Dobson & Barlow, of Bolton, which is 367'6" (see American Machinist, June 19, 1890). Formerly it was higher by some yards, but was cut down. Originally it was a chemical works shaft.

There is another high chimney near Bolton at the bleach works at Halliwell, but it is less than the former. There was once a 400-foot chimney, I have been told, at Musprall's chemical works, but it collapsed many years ago. The best proportioned shaft in Lancashire is that at the print-works of Messrs. Schwabe at Rhodes, Middleton. It is octagonal, 101 yards high, and another shaft by the same builder—Ashton by name—is at Heaton Mersey, and fully 90 yards high. The general size of cotton-mill chimney is 200 feet, and they are now always built of circular section. There is a chimney of—I am told—300 feet at Greenhithe, down the Thames in Kent, which serves cement furnaces, but the two biggest stacks in the world are in Glasgow, and are described in the American Machinist of June 19, 1890.

W. H. Booth.

Mr. Emerson Bainbridge read a paper at the recent meeting at Sheffield, of the Institute of Mechanical Engineers, on the Poetoch freezing process for sinking shafts in quicksands. It seems that the process has been used with much success in Germany. For sinking a shaft 11 feet in diameter, eighteen tubes are driven into the ground in a circle. These tubes are 6 inches diameter, and have an internal tube 2 inches diameter, through which the freezing medium (which may be brine) is forced to the bottom, rising through the annular space between the tubes. When the ground becomes frozen to radius of about 10 feet, shaft-sinking operations can begin. No blasting can be done, however, for fear of breaking the tubes, and the work must be done by the drill and pick.

The following is a recent press dispatch from Augusta, Me.: "The Railroad Commissioners issue a notice to all railroads that the methods of heating cars granted last year expired by limitation July 1. On August 12 the commissioners will be in session to receive applications from railroads for desired methods. Inventors and interested persons will be given a hearing."

Canada has about the same railway mileage, in proportion to inhabitants, as the United States.

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NEW YORK, AUGUST 21, 1890.

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Lists and Discounts.

There is an element of the ridiculous in the prevalent method of issuing price lists, and then making discounts from them in certain lines of trade, though the inexperienced buyer is apt to fail to see the ridiculous side of the matter, when he finds that while he has been buying goods at, say, 10 or 20 per cent. discount from "manufacturers' prices," supposing himself to be doing remarkably well, these "manufacturers' prices" turn out to be in reality only a fiction, at which no reputable manufacturer ever pretends to sell goods, and that the regular discounts are perhaps 50, 20, 10 and 5 per cent. off.

It is probably not possible to issue price lists that will at all times exactly represent the actual condition of things as shown by transactions taking place; but that it is possible to get much nearer actual prices than is done by many price lists, ought to be, if it is not possible. For where there is such a vast difference between list prices and actual selling values as is the case with many lines of goods, it simply gives dealers, who are so disposed, a chance to impose upon people not thoroughly familiar with the business, and to make an exorbitant profit, which is not only a virtual robbery of the innocent buyer, but, of course, works a direct injury to the manufacturer, as does every other influence which tends to increase the cost to the consumer after the goods leave the hands of the manufacturer. Of course, it is probable that there will always be discounts from lists, as it seems proper for legitimate business reasons that there should be, but that there is too much difference between list prices and actual ruling prices in many lines of trade, to serve any legitimate business purpose, there can be little doubt. Take, as an instance, the case of gauge glasses; there is a list price for these, which, so far as we know, has not been changed for years, and engineers and others who buy in small or moderate quantities are in some instances, and by some dealers, charged nearly or quite this list price, whereas actual prices have declined so that the regular trade discount, which any one who is posted and buys in moderate quantities can obtain, is over 90 per cent. No one, we think, will claim that any good reason exists for such a difference between list and actual prices, and it only gives opportunities for sharp practice, which is injurious alike to the manufacturer, to the consumer, and to the dealer who is satisfied with fair and legitimate margins.

This is one instance only, and plenty of others could be given from which arise, in part, among other evils, that of the subsidizing of railway officials who have purchasing to do, and which has become notorious.

An incident, which goes to show the condition of things, occurred recently, and is explained by the following communication from Jenkins Brothers, of this city, the well-known manufacturers of valves and packing:

We send you by this mail revised edition of our price list for 1890. A few months since we issued a reduced price list, believing it was for the best interests of the trade to have a lower list. While we still believe that, for the interest of all concerned, a lower list is much preferable to the higher lists, which are adopted by all merchants in the hardware and steam trades, we feel that we are obliged to conform to the customs of the trade.

As it is the prevailing custom to give employment to all we possibly can, we presume it is preferable for all merchants to have price lists of goods as high as possible, so that they may employ bookkeepers and mathematicians to figure the discounts. Our idea was that the nearer we could get to net prices the less trouble it would be for bookkeepers, architects and others, who have to figure the cost of valves in their specifications. It seems that we were very much mistaken in our efforts to establish a lower list. We submit gracefully to the opinion of the merchants of the United States, and revert back to our old list.

A comparison of the former list with the present one shows that the reduction in list price, proposed by Jenkins Bros., was 50 per cent., which, it is to be presumed, still left a sufficient margin for all proper purposes, and would have left the prices in actual transactions where consumers are posted, unchanged; but as the custom of the trade was against the innovation, and it seemed likely to produce endless confusion and trouble, it was concluded to be impracticable, though most of the leading manufacturers, and some of the dealers, favored it. We understand that Morris & Tasker undertook a similar reform in the pipe fittings trade some years ago, and failed to carry it through, for similar reasons.

Of course, if such firms as these cannot carry such a reform through singly, there is little prospect of its being done except by agreement and concerted action, but we believe that such a reform would be better for all concerned, and especially for manufacturers and consumers.

It has been made particularly evident, by some recent occurrences, that the building up of the manufacturing interests of a town by the enterprise of its citizens does not go well along with land speculation. It may work satisfactorily for a while, but there is pretty sure to come a time when conflicting interests will clash. We have in mind at this writing, two cities, which we will not name, in which manufacturers have been induced to locate quite extensively for two or three years past, by the inducement of cheap land, or land that cost nothing. Now, the land speculators reason that their innings have come, and, having secured the most available sites, hold them at figures that seem outrageously high to manufacturers desiring to locate. The result in each instance to which we refer is that prospecting manufacturers—in two instances, at least, large ones—have shaken the dust of these towns from their feet, and gone elsewhere.

It is, perhaps, natural enough that land speculation and manufacturing enterprise should be found together, but the best results for the town or the manufacturer are not worked out by such a union. This is especially true when all the interest there is in manufacture is to the end of increasing the price at which it will be possible to sell land.

The Machinery Molders.

We are in receipt of a pamphlet containing the address of Mr. John A. Penton, President of the Brotherhood of Machinery Molders, delivered at their fifth convention at Indianapolis. The address is a commendable one, and contains many ideas which, if carried out, can hardly fail to prove beneficial to machinery molders, and those who employ them. Its general tenor may be learned from the following extract:

Old theories and narrow ideas, whose only merit is their age, should be relegated to the background, and a constitution framed which should teach our members the need of greater education as mechanics and citizens, while meeting all the requirements of our Order, and we should at all times discourage the idea so universal as a result of false doctrines, that foremen or employers are the natural enemies of workingmen, or that one of the main features of an organization of mechanics should be the preparation or utilization of forcible means to improve their condition.

I am proud of the fact that many of our best friends and members—many of those who have taken the most active interest in our advancement, and who have most aided us during the last few years—have been the proprietors or in charge of foundries. This is as it should be, and is in line with the views entertained by the successful and best informed men in similar movements.

One of the latest devices for increasing the speed of steamships is the use of something like a rotary fan operated at the bow, the stem being cut away to afford it room. The object of this fan is to scatter the water at the bow—part it, as it were—thus doing away with a part of the head resistance, which at high speed is quite a factor. We do not commend the device.

The importation of iron ore so far this year is double what it was for a corresponding period last year. This, however, only serves to show activity here, as these imported ores are used only for mixing with native ores. The greater the quantity of ore imported, the greater the quantity of native ore used. We can get along very well indeed with such importations.

We recently received a call from Mr. Charles Churchill, of the well-known firm of Charles Churchill & Co., limited, of London, England. Mr. Churchill is an American by birth, but has lived in England twenty-seven years, for more than twenty-five of which he has been engaged in the business of selling American machinery and tools from some of the best builders. He handles machine tools of all kinds, wood-working machinery, mechanics' and engineers' tools—in fact, nearly all machinery products of the United States. While he carries considerable stock, a large part of his business is done through the use of the cable. Mr. Churchill says that the better classes of American machinery are received with favor in England, particularly machine tools for the finer kinds of work, and where convenience of operation is especially desirable. Business is very good with the firm.

A somewhat remarkable news item appeared in the papers a few days ago, announcing that the boiler of a saw-mill near Danville, Ill., had exploded, instantly killing one young man and fatally injuring his father, while the engineer had one leg torn off. So far, there is nothing particularly remarkable in the narrative, as such actions are quite common with saw-mill boilers, but the remarkable portion of the statement is in the concluding sentence, in which it is said that the accident was caused by using a worn-out boiler. It is usually "low water," or, "the cause of the explosion is a mystery." That a newspaper chap should have actually grasped the truth that boilers sometimes become unfitted for use by age and long service, and blow up, simply because they are too weak to stand the pressure put upon them, we take to be an indication that the millennium may not be quite so far off as we had supposed it to be, after all.

Thirteen minutes is rather a short interval of time by which to break the record for crossing the Atlantic, but this is just the time by which the Teutonic of the White Star line—so it is claimed—beats the best previous record—that of the City of Paris. Five days, nineteen hours and five minutes is now the best record—that of the Teutonic. The log showed 2,806 miles.

Literary Notes.

THE METALLURGY OF STEEL. By Henry Marion Howe, A. M. (Harvard), S. B. Volume I.

This work is one of great value to engineers and others who wish to become acquainted with the different processes of manufacturing, and the chemical, physical and mechanical conditions which affect the properties of iron and steel. The first fourteen chapters are devoted to the classification and constitution of steel; carbon and iron, hardening, tempering and annealing; iron and silicon; iron and manganese; iron and sulphur; iron and phosphorus; chromium, tungsten, copper; the metals occurring but sparingly in iron; iron and oxygen; nitrogen, hydrogen, carbonic oxide; general phenomena of the absorption and escape of gas from iron; the prevention of blow-holes and pipes; structure and related subjects; cold working, hot working, welding. In Chapter XV the direct process of the manufacture of wrought-iron and steel is explained, and it also contains a discussion of the possibilities of future development of such processes. In Chapter XVI is given a description of the charcoal hearth processes for the production of malleable iron from pig-iron, which are still in existence. Chapter XVII contains an admirable description of the manufacture of crucible steel. Chapter XVIII contains an excellent illustration of a 10-ton bessemer plant. The description of this apparatus is one of the best that has been written; it is given from the standpoint of a practical designer and engineer. The appendix is devoted to special steels; anti-rust castings, and lead quenching. The subject is one of great magnitude; it has been handled in a masterly manner, and the whole work shows that an immense amount of labor, research, thought, and literary skill

has been expended on it. Space will not permit us to dwell on the details of this work, but to give an idea of the labor and patience expended we shall simply refer to one of the many instructive diagrams which the book contains. This diagram shows in a graphic way the effect of carbon on the tensile strength of iron, and in it are plotted many of 1,500 tests which were gathered from many sources. The book also contains 222 tables, many of which required a great amount of calculation; and throughout the 373 pages of reading matter 228 illustrations are interspersed. The author also presents a complete review of all important conclusions reached by earlier investigators, and his masterly discussion of them will be appreciated by all interested in the subject. The work is one of great merit, and is a notable contribution to the literature of iron and steel metallurgy. The book is published by the Scientific Publishing Company, 27 Park place, New York. Price, $10.

In *The Stevens Indicator* for July Prof. H. A. Wood gives a new method of extracting cube root, by which the operation is much shortened when the root of large numbers is to be extracted. Prof. J. E. Denton continues his articles on friction, in the first of which, published in the April number, occurs the following passage: "Writers on lubrication for a number of years past have assumed that the co-efficient of friction of car service was attainable on all journals, and amongst other results of this error has been a general condemnation of the laws of friction given by the eminent scientist of the last half century, General Morin, whose work, from a practical standpoint, is still worthy of all respect."

In the present article it is shown that Morin's laws, if applied to the calculation of the friction of steam engines, afford results in satisfactory agreement with prony brake determinations.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(319) B. W. B., Bridgewater, Mass., asks: Will an ordinary watch sustain any injury from the electric current in an electric car? *A.*—If the watch is brought too close to the current it will be injured, but if it is not brought any closer than that of a passenger on an electric motor, we believe no fear need to be apprehended.

(320) G. C., Oil City, Pa., writes: I am building an engine, cylinder 10x12, with a balanced slide valve. Please give size of ports, steam and exhaust pipe; I would like to make the ports 10 inches long, also give the amount of lap. Number of revolutions, 200. *A.*—Steam ports, $\frac{9}{16}$x10 inches; exhaust port, $1\frac{1}{2}$x10 inches; bridges, $\frac{1}{2}$ inch wide; steam pipe, $2\frac{1}{4}$ inches diameter; exhaust pipe, $3\frac{1}{4}$ inches diameter; steam or outside lap, $\frac{9}{16}$ inch; lead about $\frac{1}{32}$ of an inch.

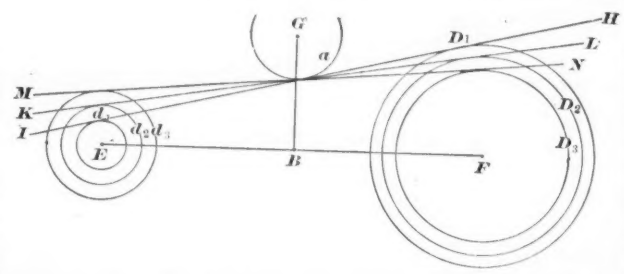
(321) J. S. R., Philadelphia, Pa., writes: In your issue of July 31, page 2, Fig. 1, the line $c\ a$ is assumed to be 4 inches long; then it is stated that $b\ a$ and $c\ a$ are equal in length, and each represents a force of 5.656 × 1,000 = 5,656 pounds. Is that right? Or should it be 2.828 inches, representing a force of 2,828 pounds. *A.*—You are right. The lines $c\ a$ and $b\ a$, measured by a scale, are each 2.828 inches long, consequently each represents a force of 2.828 × 1,000 = 2,828 pounds. But it must be remembered that, for a given load, the lengths of the lines $c\ a$ and $c\ b$ will depend on the angle formed by the beams, and it is a very easy matter to increase this angle so that the lengths of the lines $c\ a$ and $c\ b$ will each be 5.656 inches long, and in that case each line will represent a force of 5,656 pounds.

(322) T. J. W., New York, writes: In our plant we have a $1\frac{7}{16}$-inch shaft running 200 revolutions per minute. It is running too fast for our machines. Now what I would like to know is, if I put a 32-inch pulley in the place of a 27-inch pulley, 6 inches face, as it now is, would the shaft be strong enough without putting hangers close at each side of pulley? The hangers are now 5 feet apart, one being close to pulley and at the end of shaft. Speed of engine is to be 150 revolutions per minute; driving wheel, 32 inches diameter 6-inch face, single belt, 6 inches wide and about 30 feet from end to end. *A.*—We should put a hanger close to each side of pulley; the shaft is light for the power which the belt can transmit.

(323) E. O. S., Syracuse, N. Y., writes: Please inform me how to solve the following problem: I wish to find the size of a hollow sphere with a shell $\frac{1}{8}$ inch thick, that contains exactly an amount equal to a solid sphere, 1 inch in diameter. *A.*—The inner diameter of the sphere will be $1\frac{1}{32}$ inch very nearly; the outer diameter will be $1\frac{9}{32}$ inch very nearly. To find these diameters is a problem in algebra. The volume of a sphere is found by multiplying the cube of the diameter in inches by .5236, the product will be the volume in cubic inches; hence the volume of a sphere 1 inch in diameter will be .5236 inch; which, according to the conditions of the problem, is also the cubic contents of the shell of the hollow sphere. Now let x represent the inner diameter of the hollow sphere, then the volume of the inside of the sphere will be $x^3 \times .5236$. The outer diameter of the sphere will be $x+\frac{1}{4}$"; and the volume of a sphere of this size will be $(x+\frac{1}{4})^3 \times .5236$. Subtracting the inner volume of the sphere from the outer we have the contents of the shell, and which, according to the conditions of the problem, must be equal to .5236. We have, therefore,
$.5236\ (x+\frac{1}{4})^3 - .5236x^3 = .5236$. This equation will reduce to $(x+\frac{1}{4})^3 - x^3 = 1$. From this we get $x = 1.025$, which is very nearly $1\frac{1}{32}$ inch, for the inner diameter of the sphere. The outer diameter will, of course, be equal to the sum of the inner diameter and twice the thickness of the shell, that is, $1\frac{1}{32} + \frac{1}{8} + \frac{1}{8} = 1\frac{9}{32}$ inch.

(324) F. G. M., London, Ont., writes: Kindly answer the following questions: I am running a common slide-valve engine, compound, non-condensing, with automatic cut-off governor. The high-pressure cylinder is 8 inches diameter; low-pressure, 14 inches; stroke, 22 inches. The engine is working at her full capacity, the governor is not allowed to cut off. I claim that by converting the engine to a simple engine and working the low pressure high, and doing away with the small cylinder and using the automatic governor, we shall have a better result. Also, please let me know the indicated horse-power of the engine as she is now, and the power she would be with the big cylinder alone. The engine runs at 102 revolutions per minute; boiler pressure, 80 pounds. *A.*—If the engine is properly constructed, you may obtain better results with the compound type than with the simple type to which you propose to change the engine. That is to say, you may need less coal per indicated horse power before the change is made than afterwards, although the simple engine may develop a greater horse-power than the compound engine. In order to give the horse-power of the compound engine with a degree of exactness, more data than you have given is required. If the ratio of expansion is 4, then the engine will develop about 60 indicated horse-power. If the large cylinder only is used, with the same initial steam pressure as before, and cutting off steam at half stroke, about 100 horse-power will be developed, but more coal per horse-power may be required. Of course the horse-power here given is only an approximation. Whether you can use such a high initial steam pressure in the large cylinder will depend on the strength of the different parts of the engine.

(325) G. B., Newark, N. J., writes: Please give me a rule for finding the diameters of the steps of a cone pulley when the diameter of one of its steps, and the diameters of all the steps on the other cone are given. For instance, I have a cone pulley whose steps are 2, 3 and 4 inches diameter; the diameter of the large step on the other cone pulley is 18 inches; distance from center to center is 6 feet; what should be the diameters of the other steps? *A.*—For the solution of a problem of this kind we believe a graphical method is the best one to adopt. The method that we shall use here was given by Mr. C. A. Smith, and published in our issue of December 1, 1888. Lay off the centers E and F six feet apart, and join them by a straight line. From E as a center, and with the radii of 1, $1\frac{1}{2}$ and 2 inches, describe the circles d_1, d_2 and d_3 to represent the steps of the small cone pulley. From F as a center, and with a radius of 9 inches, describe the circle D_1 to represent the large step on the other cone pulley; draw a line $I\ H$ tangent to the circles d_1 and D_1. Through the point B midway between the points E and F draw a line $B\ G$ perpendicular to $E\ F$. On $B\ G$ lay off a point G; the distance between B and G must be equal to $E\ F \times .314$; in this example $B\ G$ will be equal to $6 \times .314 = 1.884$ feet. From G as a center describe the circle a tangent to $H\ I$. Draw a line $K\ L$ tangent to the circles d_2 and a, and from the center F describe the circle D_2 tangent to the line $K\ L$; the diameter of the circle D_2 will be the diameter of the second step on



the large cone pulley. Lastly, draw the line $M\ N$ tangent to the circles d_3 and a, and from F as a center describe the circle D_3 tangent to $M\ N$; the diameter of this circle will be that of the remaining step on the large cone pulley. If this construction is carefully made, the required diameters of the steps on the large cone pulley will be nearly $17\frac{1}{4}$ and $16\frac{8}{16}$ inches in diameter. This construction is only suitable when the greatest belt angle does not exceed 18°. For greater belt angles the construction has to be slightly modified. See paper by C. A. Smith previously referred to.

BUSINESS SPECIALS.

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Friday morning for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 20.

Link-Belting and Sprocket Wheels.
Send for Catalogue of Link-Belting.
Over 50,000,000 feet of Link-Belt in use.
Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

"The Bulldozer," a new departure; forging by pressure. M'f'd by Williams, White & Co., Moline, Ill.

Pattern and Brand Letters. Vanderburgh, Wells & Co., 8 Spruce St., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Ice and Refrigerating Machines, 155 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

"How to Keep Boilers Clean." A 96-page book mailed free by Jas. E. Hotchkiss, 120 Liberty st., N.Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Universal and plain Milling Machines. Pedrick & Ayer, Philadelphia, Pa.

Portable Cylinder Boring Machines. Pedrick & Ayer, Philadelphia, Pa.

Standard Tool Co.'s Twist Drills. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Get particulars of our new Wall, Suspended and Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

Audubon Machine Works, New Haven, Conn. Special machinery, heavy and light.

One Star Hack Saw will do as much work as five of any other kind.—N. B.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See August 7, p. 19. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Send $1 for Catalogue D, Fine Tools and Supplies. Over 550 pages. Fully illust'd. Free when $10 worth goods are ordered. Frasse & Co., 92 Park Row, N.Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

Horton's Chucks. We offer the balance of our stock at 50 per cent. discount. McFadden Co., Philadelphia, Pa.

Inventors—Electrical and mechanical models of any description made to order; strictest secrecy maintained. Sugden Bros., 24 Stone st., N. Y.

"Roper's Hand-Books," for engineers and firemen. Send for descriptive catalogue. Address Edward Meeks, publisher, Philadelphia, Pa.

25" 32" 37" 42" Upright Drills a specialty. Finely made, great capacity, quickly operated, prices low. Send for list of firms using our Drills. J. E. Snyder, Worcester, Mass.

25" 32" 37" 42" "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, New Ark, N. J.

For Sale—Bound volumes of the Patent Office Gazette for years 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per year. Address J. C., care of AMERICAN MACHINIST.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations, 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines. T. C. Dill Machine Co., Philadelphia, Pa.

Screw Propellers. Manufactured by H. B. Roelker, 22 Cortlandt st., New York. Superintendent of the late De Lamater Iron Works, of same patterns and designs as before, adapted to each vessel. Consulting Expert and Constructing Engineer. Estimates on machinery, damages, etc. Air ice machines.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

MANUFACTURES.

A large new iron furnace is being erected at Radford, Va.

It is stated that a jewelry factory will be started at Abilene, Tex.

A stove foundry will probably be erected at Kingston, Tenn.

A cotton factory will probably be erected at Buena Vista, Ga.

A cotton gin and grist-mill are reported as erected at Santo, Tex.

Negotiations are pending for the erection of a woolen-mill at Iron Gate, Va.

Rhode Island capitalists will erect a $30,000 cotton-mill at Charlottesville, Va.

It is stated that Robert Dawson will establish an ice factory at Arkadelphia, Ark.

A stock company is reported as organized, to erect a saw-mill, at Bristol, Fla.

A cotton-mill at Bluffton, Ala., is to be erected. The plant will represent $100,000.

The Yocona Mills, Water Valley, Miss., contemplates putting in new machinery.

A new knitting factory will be started at Kingston, N. C. Capital stock, $10,000.

The West Lynchburg Land Company, Lynchburg, Va., will soon erect a woolen-mill.

The Glove Iron Foundry, at Erie, Pa., is to be enlarged, doubling its present capacity.

A stock company is reported as organized, to erect an ice factory at Atlanta, Tex.

A yarn-mill at Kershaw, S. C., is controlled by a company representing $50,000 capital.

A new pulp-mill is being built at Berlin, N. H., by the Glen Manufacturing Company.

Dyer & Hughes, of Foxcroft, Me., have broken ground for a piano factory, 60x106 feet.

A $50,000 stock company is reported as organized to erect a steam laundry at Monroe, La.

A Wisconsin company will erect a plant for a large woolen-mill at Chattanooga, Tenn.

The Troy Iron Works, recently destroyed by fire at Troy, Ala., are to be rebuilt without delay.

A Michigan lumber company will, it is stated, erect a saw-mill at Baton Rouge Junction, La.

A plug-tobacco factory, representing a capital of $250,000, is about to be started at Danville, Va.

A $100,000 stock company is reported as organizing at Orangeburg, S. C., to erect a woolen-mill.

There is a prospect for a $100,000 plant for the Shippers' Compress Company, at Hillsboro, Tex.

A new spike-mill is to be built at Roanoke, Va. The machinery is modeled after a Pittsburgh mill.

A large new pulp-mill is to be built at Madison, Me., by the Manufacturing Investment Company.

Beard & Son, of Greenville, S. C., will erect a foundry and machine-shop at Spartansburg, S. C.

The Rome Cotton Factory, of Rome, Ga., is going to increase its capacity and put in new machinery.

J. H. Gould is reported as organizing a stock company to erect a bicycle factory at Huntington, Va.

A stock company is reported as being organized, to erect an electric light plant at Greensborough, Ala.

An iron foundry is to be added to the plant of the Moffat Manufacturing Company at Chester, S. C.

The Citizens' Railway Co. is erecting a plant to operate its street-car lines by electricity at Waco, Tex.

The Prattville Cotton-mills, Prattville, Ala., are intending to soon double the capacity of their mill.

A company is being organized at Belton, Tex., for the purpose of erecting a 5,000-spindle cotton factory.

Carley Brothers, Colfax, Wash., will build a foundry to run in connection with their machine shop.

A $50,000 stock company will probably be organized to erect a brewery and ice factory at Griffin, Ga.

A corrugated iron building will be erected at Bluefield (W. Va.) Iron Works, and new machinery added.

The machine shops of the South Atlantic & Ohio Railroad Company, at Bristol, Tenn., are being enlarged.

The Thomson-Houston Electric Company, of Boston, Mass., will erect a plant in Yazoo, Miss., to cost $60,000.

A machine shop, 40x60 feet, is reported as about erected at Rome, Ga. J. A. George can give information.

The factory is to be enlarged and new machinery to be put in at the Croft's Fiber Company, at Croft's, S. C.

The Aurora Electric Light Company has been granted a franchise to erect an electric light plant in Delaven, Ill.

The knitting-mill to be located in Oxford, N. C., will give employment to from seventy-five to one hundred girls.

The Putnam Manufacturing Company, Putnam, Conn., is to increase its business by the addition of fifty new looms.

Dyer & Hughes, Foxcroft, Me., are to erect an additional building, 60x100 feet. It is to be used as a piano factory.

E. M. Johnston is erecting a saw-mill on Peggies Island, and may add a planing-mill and dry-kiln at Burgaw, N. Cal.

Two 10-ton ice machines will be erected at the Chattanooga (Tenn.) Brewery. E. D. Kohn can give particulars.

The erection of an electric light plant is projected at Mammoth Springs, Ark. E. L. Hutchinson can give information.

Ross & Willis, lately mentioned, will, it is reported, add flour-mill machinery to their grist-mill at Greensboro, N. Cal.

The Selma Electric Light and Gas Company will, it is reported, erect an incandescent electric light plant at Selma, Ala.

B. F. Harwood is reported as erecting the cotton compress previously reported, at a cost of $35,000, at Uniontown, Ala.

The Delaware Pulp Works, at Wilmington, Del., have shut down for extensive repairs to the buildings and machinery.

The Fitchburg Steam Engine Company (Fitchburg, Mass) will enlarge its works in the fall. Rush of business is the cause.

The Deuravant Cotton Manufacturing Company, Morgantown, N. C., contemplates doubling the capacity of its cotton-mill.

Crawford & Co. have, it is reported, purchased 1,600 acres of timber land near Redfield and erected a saw-mill at Redfield, Ark.

E. T. Stewart will rebuild his machine-shop recently reported as burned, erecting a building 124x27 feet, at Washington, N. Cal.

It is stated that the South Side Artesian Ice Co. is being organized to erect an ice factory, the capital stock to be $25,000, at Fort Worth, Tex.

It is stated that a $45,000 stock company will be organized to manufacture ice at Frederick, Md. David Lowenstein is probably interested.

The Cowpens (S. C.) Manufacturing Company will, it is stated, increase its capital stock to $50,000 and put new machinery in its cotton-mill.

Work has begun on the new factory of the Excelsior Needle Company, at Torrington, Conn. The main building will be 261x34 feet, with ells.

A. E. Huddlestun is rebuilding his planing-mill at White Sulphur Springs, W. Va., recently destroyed by fire, and will put in some new machinery.

A stock company has been organized with J. S. Ober as president, and H. W. Hynson as secretary, to establish a canning factory at Ridgely, Md.

G. F. Arnold, of Houston, will organize a $50,000 stock company to establish the brick and sewer-pipe works, lately mentioned, at Garrison, Tex.

It is stated that the Birmingham, Powderly & Bessemer Street Railway Co., of Birmingham, Ala., will rebuild its machine shops in Bessemer, Ala.

B. F. McCormick & Son, lately mentioned, have, it is stated, purchased $30,000 of real estate, and will probably erect a saw-mill at Lexington, Ky.

The Jacksonville, St. Augustine & Halifax Railway Company (office, Jacksonville) will, it is stated, build machine shops in St. Augustine, Fla.

C. A. Waller, A. H. Benners, Charles Stollenweick and others have organized a stock company to erect an electric light plant at Greensboro, Ala.

The Christian Moerlein Brewing Company, of Cincinnati, Ohio, will, it is reported, erect a $25,000 cold storage and bottling plant in Birmingham, Ala.

The Moore Iron Works, with a capital stock of $50,000, has been incorporated by J. F. White, W. B. Manchester, C. E. Lee and others, at Fort Worth, Tex.

The committee of the new foundry and machine company, of Dexter, Me., have secured a site and will at once begin the erection of a building 50x140 feet.

The Commonwealth Cotton Manufacturing Company, Durham, N. C., lately reported as to erect a cotton-mill, has, it is stated, purchased a site for $5,000.

W. J. Stowers, M. D. Shelby, W. D. Delong and others have received a charter to erect an electric light plant and construct water-works at Morrilton, Ark.

It is stated that the Crawfish Springs Land Company, lately mentioned, will build two iron furnaces and a number of coke ovens at Crawfish Springs, Ga.

The Hilliker-Krebs Building and Manufacturing Company has contract for erection of a machine shop for the Bessemer Pipe Works, 67x140 feet, at Bessemer, Ala.

It is reported that the Standard Steel Works, of Pittsburgh, will remove to Chester, Pa. The works are controlled by the Baldwin Locomotive Works, of Philadelphia.

A company is organizing at Sykesville, Md., to establish a plant for the purpose of manufacturing Day's Climax, all-steel cultivator, and other agricultural implements.

Stimpson & Steele, at Turnersburg, N. C., are rebuilding the cotton-mill destroyed by fire, and formerly belonging to W. Turner & Co. The work is progressing rapidly.

The iron foundry belonging to the Humphrey Machine Company, Keene, N. H., was recently burned, with a stock of valuable patterns. Loss about $10,000, with no insurance.

W. A. Allen, of Portland, Me., manufacturer of building trimmings, is rebuilding his burned factory on Preble street. The new structure is to be 50x87 feet and three stories high.

The electric light plant, previously reported as being erected by the Belt Land Co., will be operated by the Central Electric Co., shortly to be organized at Lexington, Ky.

It is stated that the Southern ice manufacturers will hold a meeting for the purpose of organizing a stock company to erect an ammonia factory, either in New Orleans, La., or Galveston, Texas.

The National Wire Nail-mills, of Chicago, have been incorporated, to make and sell wire nails. The capital stock is $250,000, and the incorporators are H. E. Piggott, G. R. Bispham and H. C. Gerke.

A company has been formed in Philadelphia, it is stated, to erect a rolling-mill and a bolt, nut and rivet plant, under the title of the Townsend-Hoopes Manufacturing Company, at Radford, Va.

The Anniston Carriage Works has been organized with J. A. Fry as president, and R. St. John, secretary, to operate the carriage factory of J. A. Fry, at Anniston, Ala. The plant will probably be enlarged.

New cotton-mills are to be erected at Mount Airey, N. C., capital $30,000; at Laredo, Tex., capital $300,000; at Durham, N. C., capital $100,000, and at Huntsville, Ala., with a capital stock of $1,000,000.

The Gulf Wire-mill Company, at New Orleans, has decided to increase its capital stock to $100,000. The company is now preparing to erect a wire-drawing plant which will need 300 horse-power additional steam.

The Oliver Iron and Steel Company (Pittsburgh, Pa.) will replace its wire factory, destroyed by fire a few months ago, by a $65,000 brick building. It will be erected on the old site, and will be 243x140 feet in dimensions.

A company, comprising Charles Shaw, C. M. Sawyer and others, has been formed at Dexter, Me., for the purpose of purchasing the old tannery and building a machine shop which will give employment to fifty hands.

Gaffney City, S. C., will soon have a cotton factory. Nearly all of the capital stock of the concern, which is $100,000, has been taken, and there seems to be no doubt that it will be built. A. N. Wood is the president of the company.

The $1,000,000 cotton-mill to be erected near Montgomery, Ala., will be occupied by the machinery of a large cotton-mill in Philadelphia, Pa. The plant is to be removed to its new quarters as soon as the mill shall be completed.

J. P. Gay and others, under the corporate title of the Smithdale Iron Company, will build one or more iron furnaces at Lawrenceburg, Tenn., and G. T. Hughes and others, of Columbia, Tenn., will also build a furnace at that place.

The buildings which are to be occupied by the Valley Engine & Machine Co., at Lynchburg, Va., will be 120x40 feet, 120x50 feet, 100x58 feet and 22x24 feet. The structures are to be fitted with all the facilities of modern machine shops.

The Boney Tank, Mining and Manufacturing Company has been incorporated at Roanoke, Va., with J. W. Coon, secretary, to operate mines in Georgia, and is privileged to erect mills, furnaces, etc. The capital stock is $2,000,000.

The Thomson-Houston Electric Company, of Boston, Mass., has, it is reported, purchased the electric light plant of the Middlesborough Gas and Electric Company for $30,000, and will organize a stock company to operate the same.

The steel plant which the Norton Iron Works and the Kelly & Belfont Mills, of Ironton, O., propose building, as lately stated, will cost from $350,000 to $400,000. It is said that $100,000 of the capital stock has been subscribed in Ashland, Ky.

The Chesapeake & Ohio Railroad, Cincinnati, Ohio, has commenced work on its shops near Clifton Forge, W. Va. It expects to spend three-quarters of a million dollars. All the repair work east of the Ohio River will be done at this point.

The $300,000 stock company, heretofore mentioned as organized at Goshen Bridge, Va., to construct a rolling-mill, has been incorporated as the Goshen Rolling-mill Company, with Harry Stephen, president, and J. Y. Heckman, secretary, both of Philadelphia.

The Thomson-Houston Electric Welding Company, of Lynn, Mass., is building large works at Newark, N. J., which will be used principally for the welding of tubes. E. P. Ball, of Palmer, Mass., is the engineer, and furnished the plans for the new factories.

A. Randall, of Griffin, has the contract to erect the cotton bagging factory, lately reported at Americus, Ga., as to be established by the Southwest Georgia Alliance Manufacturing Company. The main building will be 50x146 feet, with a wing 24x70 feet.

The Land, Timber, Iron & Marble Development Co. owns the 25,000 acres of timber land in Cocke and Sevier counties lately referred to, and will develop as previously reported, locating saw-mills on the property and woodworking machinery in Morristown, Tenn.

Parties have gone East to place an order for the machinery for the South Dallas (Tex.) Cotton-mill. Work has commenced on the buildings. The entire plant will cost about $65,000, and it will be in operation just as soon as the machinery can be built and set up.

The $25,000 stock company, lately reported as organized, will be known as the Opelika Flour-mills, and has for officers W. B. Shaphard, president; J. B. Trammell, secretary. A site has been purchased, and a mill with capacity for 300 barrels per day will be built at Opelika, Ala.

The new building of the Rockingham Company, at Exeter, N. H., is fast nearing completion, and will soon be ready for occupancy. The building is 100 by 35 feet inside measurement, and is of wood, with brick foundation. The engine and boiler-room will be of brick, 24 by 35 feet.

A cotton factory will soon be built at Wellford in Spartanburg county, S. C. Nearly all the capital stock has been taken. The capital stock will be $50,000, and the mill will manufacture yarns and cloth. J. J. Vernon, T. E. Moore, J. R Snoddy and G. G. Patterson are the prime movers in the enterprise.

The Crescent Soda and Salt Company has been incorporated with $1,000,000 capital stock, and will either erect works at Cloverport or Brandenburg, Ky., for the manufacture of soda ash on a large scale. The works are to be completed in four months. Bennett H. Young, of Louisville, is president.

The Marinette Iron Works, Marinette, Wis., write us, in reference to the large works they are building at West Duluth, Minn., that they will manufacture a complete line of Corliss engines. They also propose to go extensively into the building of marine engines, both high and low pressure, compound and triple expansion.

The Salem Car and Machine Company has just been organized at Salem, Va., by capitalists from New York, Boston, Maine and New Hampshire. The authorized capital is $500,000. Work on the new plant will begin as soon as the formation details are completed. J. W. Allemong is president; W. U. B. Stinson, of Concord, N. H., is vice-president.

Brown & Mansur, of Houlton, Maine, are nearly ready to commence work in their new foundry and machine-shop. Two large buildings and a brick boiler-house have been erected. When their establishment is completed they will have the best equipped and most complete outfit for manufacturing stoves, plows and machinery in Aroostook county, Maine.

J. W. Britton has bought the unused merchant mill, formerly of the Union works of the Illinois Steel Company, and will remove it to Cleveland, Ohio. He has a site on the lake front, east of the Britton iron and steel works, on which he will erect the plant. The expectation now is that he will have in operation, in 60 to 90 days, a mill making plates and sheets. A sheet galvanizing department will be added.

The Cabot Manufacturing Company, of Brunswick, Me., are getting plans for a large extension to its present mill. This new addition will be used for a weaving department. The looms will be taken from its old mill, and carding and spinning put in their place. A large number of new looms will also be added. It will also throw out a large portion of the carding and spinning machinery in its old mill and put in new.

The final contract was signed in London, England, last week, for the steel plant of the Watt Iron and Steel Syndicate, of Middlesborough, Ky. Mr. J. P. Witherow, of Pittsburgh, Pa., who has been in England for some time, secured the contract. The plans have been materially altered from the original design, which caused the delay in closing up the deal. It is said the Middlesborough steel plant will be the finest in this country.

The contracts for building the new factory of the Bridgeport (Conn.) Chain Company, which is soon to be erected, have been awarded to H. M. Purdy and A. W. Burritt, the former to do the mason work and the latter to have charge of the carpenter work. The company manufacture all kinds of halter, dog, post, sash, trace and picture chains, and are at present doing a large business. They now employ about fifty hands, but when the new factory is started, it is expected that at least one hundred hands will be employed.

The West Superior (Wis.) Iron and Steel Co. are going to build two blast furnaces and bessemer steel converters to give an output of 120 tons of ingots each shift; also one large mill for making ship-plates and a large structural beam mill. Mr. Joseph Parkes, who formerly was manager of the Minnesota Iron Car Co.'s works at Duluth, Minn., and who have closed their works pending a reorganization of the company, was appointed superintendent of the West Superior Iron and Steel Co. Mr. Parkes thinks it will take about a year to build it.

Detrick & Harvey Machine Company, of Baltimore, Md., have just completed an extension to their machine shop of 70x90 feet. Among other machine tools that they have in course of construction is one of their "F" open-side extension planers, to plane 10x9x25 feet, weight 90,000 pounds, for the Walker Manufacturing Company, Cleveland, Ohio, and a similar machine, to plane 16 feet long, for the Stearns Manufacturing Company, Erie, Pa.; also three threading and slotting machines for guns of 8" to 12" caliber, for the Watervliet Arsenal, West Troy, N. Y.

It is proposed to organize a power company in Kansas City, Kan., with a capital stock of $1,000,000. The name of the new institution is the Interstate Water and Electric Power Company, of Kansas City, Kan., and the plant is to be established near Muncie, Wyandotte county. The new corporation is backed by leading capitalists, who propose to dam the Kaw River and furnish power to manufactories, and an immense electric light plant. Already 203 acres of land have been purchased at a large cost, 173 acres lying on the north side of the river and 30 acres on the south side.

The National Water Tube Boiler Co., of New Brunswick, N. J., are very busy on large orders for their boilers, and have found it necessary to increase their facilities to keep pace with their rapidly-growing business. They have recently added an extension to their works, and are putting in additional machinery, which will greatly facilitate deliveries. The "National" boilers are now in use in almost every State in the Union, and in many foreign countries. A plant of about 600 H. P. of these boilers has been lately erected for the Sawyer Man Electric Co., in Twenty-third street, New York.

The Bridgeport Boiler Works, Bridgeport, Conn., report that within a short time they have installed plants and additions to plants of Lowe boilers, with all improvements, and have orders for others, the most noteworthy of which are a pair of 100 horse-power each, to increase a plant of 600 horse-power to 800 horse-power, for the Ansonia Brass and Copper Company, Ansonia, Conn.; a plant of 600 horse-power, to be increased to 800 horse-power, to the Aluminum Brass and Bronze Company, Bridgeport, Conn.; a pair of 120 horse-power each, to increase a plant of 200 horse-power to 440 horse-power, to the Long Island Brewery, Brooklyn, N. Y.; a pair of 100 horse-power each, to increase a plant of 250 horse-power to 450 horse-power, to Messrs. Edward Miller & Co., Meriden, Conn.; a 75 horse-power to the New York Belting and Packing Company, to increase their Lowe boiler capacity from 500 to 575 horse-power; one 100 and one 125 horse-power, for Messrs. Russell, Burdsall & Ward, Port Chester, N. Y., to displace a pair of water tube boilers, after a practical experience with two kinds of leading water tube boilers and the Lowe boiler, and tests of all three.

Mining by Electricity.

The Monongahela Gas Coal Company, at its bituminous coal mine near this city (Pittsburgh, Pa.), has successfully demonstrated the utility of electricity in mining, and somewhat revolutionized operations in the bowels of the earth. Electricity mines the coal, fans the air to ventilate the chambers, pumps the water that accumulates along the entries, and lights the passages and rooms. All the miners have to do is to operate the motors and bring out the coal. This latter is still done by mules, although arrangements are being made now for a haulage system that will be run by electricity. American and English miners, who are undoubtedly the best in the world, are becoming very scarce hereabouts. Operators are frequently unable to get enough to run their mines properly, and as a result are unable to meet their orders in busy seasons. This trouble in obtaining men induced the Monongahela Company to turn over their mine at Arllock Station to an electric experiment.

The mine is to-day turning out nearly 300 tons of coal every twenty-four hours. This is done with about forty-five men and boys, quite a number of whom are employed at what is known as dead work. Under the old system it would have required about 120 men to accomplish the same amount of work. Increased capacity is not the only advantage secured. Instead of being a grimy,

uninviting place, the mine is neat and comparatively clean. The entries and rooms are well lighted, the air is delightfully pure, and the floor is as dry and hard as the ground outside. At the entrance of the mine is the power house, in which are the dynamos, generators, and engines, all of which are run by one man, who attends to the billing of the cars, and looks after his tools in his leisure time. Incandescent lamps are used for lighting. The fan is operated by a small motor.

In case of fire the air currents can be reversed, and the smoke can be driven to any part of the mine desired. The electric pump is on a truck, and can be moved to any part of the mines as easily as a wheelbarrow could be trundled. The wires can be connected and the water started any place in the mine.

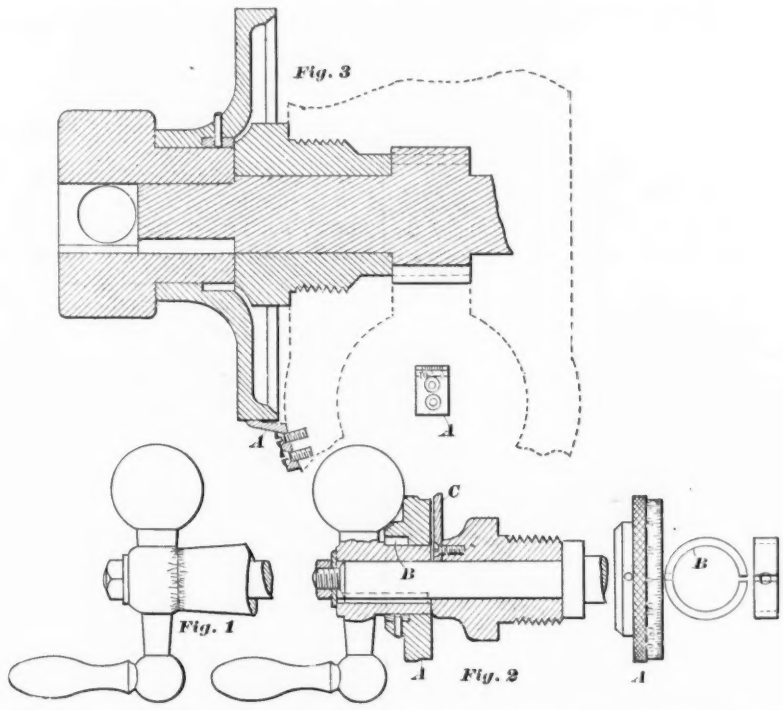
The mining machines are the real features. Five of them are now in operation. Only one man is required to operate them, and all he has to do is to start the machine by closing an electric switch, and stop it after its work is done. The machines cut in under the coal, and a little charge of dynamite brings it all down ready for hauling away. By machine it costs forty-six cents a ton to put coal on the car, by hand seventy-nine cents.—*Philadelphia Press.*

About Measurements—Work Spoiled.

By a Mechanic.

I believe it is customary for some temperence lecturers to have an old broken-down man, to sit on the platform and act as the "horrible example." I have got a little reformation or hobby to advocate, and I think best to follow suit, so take Fig. 1 for my "horrible example." This is to be seen in almost every machine shop, and by any one who takes the trouble to look. Some will think this is an evidence of the presence of the "mullet head" machinist. I do not look at it in that light, but as a good suggestion. It has been my experience to see the workmen in the shops where I have been, very industrious and intelligent, and to compare very favorably with any other class of people I have ever met. They can usually give good reasons for doing as they do, and this is better than we find some able to do. We see lots of improvements in machine tools, in the way of making them more substantial and rigid, and some things for convenience, but we see little to help us in working to our measurements. As a rough estimate, I will say it takes as much time to obtain sizes and make measurements and calculations, as it does to take off the stock, so anything to help in this direction ought to be acceptable. The universal milling machine would lose one of its most valuable features in the graduated dials. I see that some makers have adopted them on the down feed of their planers.

I have seen lately one applied to the cross screw of a lathe, which I show in a modified form. The one I saw was a hand-wheel with the graduations on the rim, with the pointer adjustable. The disadvantage with this is that, as it is best to make the calculations from the zero point, sometimes a man would have to lie down on the floor and look up at it. The one I show in Fig. 2 is a ball crank with an extended hub, and the dial *A* fitted to it with the friction ring *B* recessed in its back, and the pointer *C*. With 5 pitch screw, and 200 graduations on the dial, it will read in thousandths.



In Fig. 3 I show a dial as applied to an upright drill. It would be necessary to cut rack and pinion with cutters made to circular pitch, I think. The one I show is to have the rack move 6 inches to a revolution, and 48 lines on one side of the dial, to read in eighths, and 60 on the other side, to read in tenths. Two plates, one shown, are one above the other, one extended to match the lines on further side of plate, so as to make the eighths read in sixty-fourths, and one to match the lines on inner side to make the tenths read one-hundredths. I think any one can see the advantage of this, so I will not say more about it, but go back to the lathe.

I believe in the micrometer caliper, and I believe an extension one, for a price within the reach of people generally, is something we need. Where standard sizes are in use it is more convenient to use the micrometer caliper than any solid gauge, and I think it ought to cost less than so many gauges. With a micrometer caliper, and a lathe fitted with a graduated dial to read in thousandths, we can rough out a size and measure it, and by the use of the dial know when we have the tool properly adjusted to take off the remaining stock. This, if taken advantage of, would help. In turning a piece with a number of sizes, we can turn the large size first, and then adjust the tool by the use of the dial, for the other sizes. We can make a note of the positions as read on the dial for the different sizes, and as long as we do not change the tool we can size others in the same way. This will be found good in cutting screws, for after we get one correct, we can bring a number to the same size without so much fitting, as is usual. It is also more reliable, generally, than any stop I have ever seen, and can be put to a great many uses, and ought to be on every good engine lathe. Every one who has had experience at the machine business knows it is not best to be reckless, and it is not necessary with this. I do not say that we would be able to get the precise size every time, but it will help. "The proof of the pudding is in the eating," so it is best to be cautious and take no more chances than we can help, but it is necessary to take some. We do not know that we can accomplish anything, but by having confidence and good judgment we do well.

I once heard a foreman say he would not want a man who never spoilt anything; that he would be so very slow, he would not be worth anything. I think there is a great deal of truth in this, and one of the strangest things I have ever noticed, is that every mistake is totally unexpected. A man can work very carefully, and take air chips most of the time, and have no possibility of spoiling or breaking anything, but when a man tries to do what is right, and tries to take big cuts and get some work out of a tool, his judgment is sometimes liable to err, and sometimes he will break something. This ought to be expected, as man's judgment is always liable to err. I believe in every business enterprise they take into consideration the profits and losses. If the manufacturer can have his workmen pay all the losses, no doubt his business will be very profitable; but would this be fair? I have no doubt but that a great many times there are tools broken and work spoilt when the workman is to blame, on account of incompetency or lack of interest. In this case it is the employer's right to let such men go, or make their pay correspond. Good, intelligent, industrious men are in the business, and a great many more would be, if they were treated differently.

One of the things that hurts a mechanic a great deal is putting in young, incompetent men as petty bosses. I suppose the manager's idea is that they are only for conveying orders, and that a cheap man is what they want. It is very galling to a good many to have such a one put in a position that gives him a right (which he uses) to go about and bulldose men, who are in every way his superior.

In a great many cases where work is spoiled or tools broken, one of the petty bosses is the only one who has a right to tell who is to blame, and often he has some personal feeling against the man, and he takes a stand against him for revenge This is a trial with a judge and jury of one, and sometimes a very incompetent and revengeful one at that. I say a rule of charging workmen for tools broken, or work spoiled, as is usually practiced, is wrong, and I would like to hear some one who thinks it is right give his reasons.

Rocking Grate Bars.

The rocking grate bars, of which we give illustrations, have been brought out, and are now manufactured by the National Iron Works, New Brunswick, N. J. These grate bars possess several new and novel features, which enhance their value over the ordinary bars, and will undoubtedly be appreciated by all users of steam plants. Fig. 1 represents a set of these bars complete, and plainly shows the principle of design.

The shaking of the grates is accomplished from the outside of the furnace, without opening any doors whatever. The whole shaking arrangement is so clearly shown that it is only necessary to mention one of its features. There are two shaking motions of the bars; one is a limited, rocking motion. Fig. 1 represents the arrangement set for this limited motion. The other motion is one of greater extent, and is obtained by simply removing the wedge-like piece which, in Fig. 1, is shown attached to a chain.

The limited motion is used for cleaning the fires. The clinkers and ashes naturally work toward the bottom. The rocking of the grates will crush the clinkers between the bars and drop them, together with the ashes, into the ash-pit. By this method of handling the fire the use of a slice bar is not needed.

The other motion of the grate bars is for the purpose of dumping the entire bed of fuel into the ash-pit, and since this can be accomplished without opening any of the furnace or ash-pit doors, the annoyance of having dust and ashes strewn around the boiler-room, as in the case where fires have to be hauled out of the fire doors, is, to a great extent, avoided.

Rocking grate bars are naturally more costly in the first place than the ordinary bars, and therefore these bars have been designed for a greater durability than that of the ordinary bars. Consequently, the bar is provided with removable leaves, and this construction forms a special feature of these grate bars. As will seen in Fig. 2, the leaves

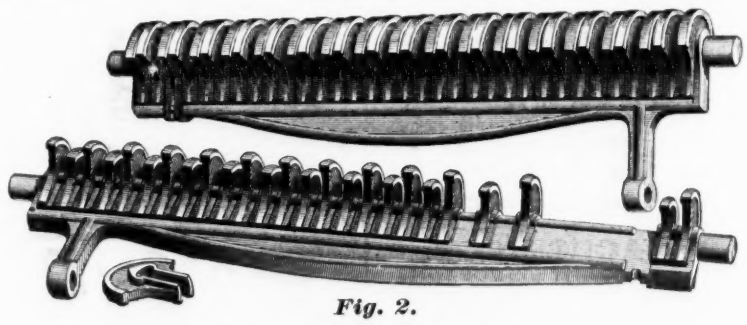
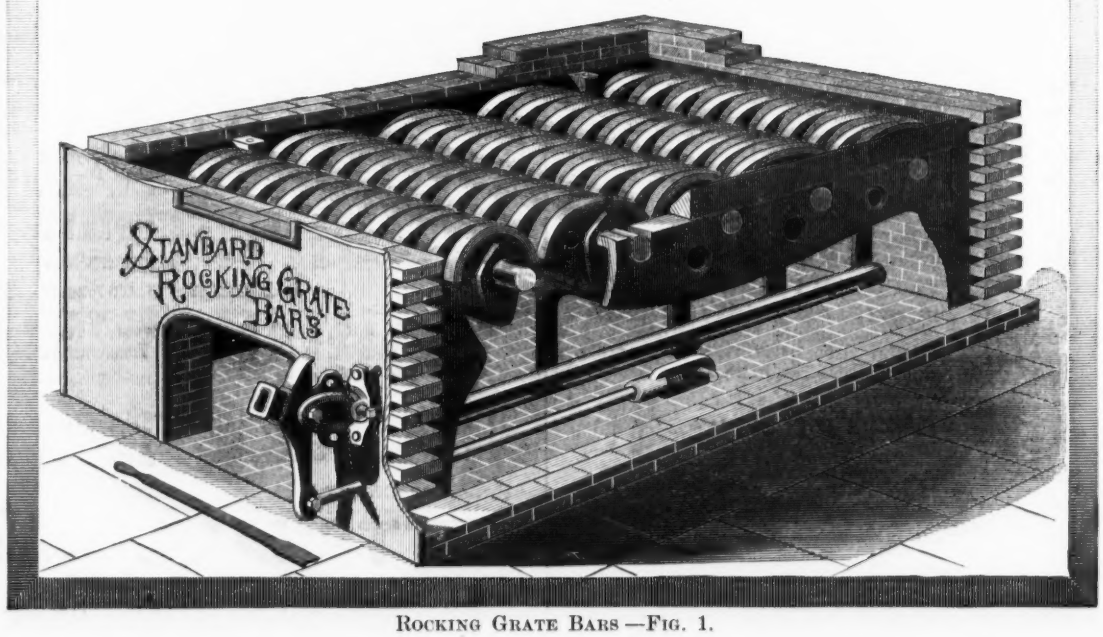


Fig. 2.



Rocking Grate Bars—Fig. 1.

are placed on the main bar by putting them on vertically in the slot, which is shown in a separate leaf at the right-hand side, and then passing them transversely into position; in other words, stringing them on the bar. The bead at the upper part of the bar keeps the leaves from being detached vertically, and after the leaves are all on, with one exception, a key-leaf is placed on the main bar at the point where the bead is discontinued. This leaf has longer shanks than the others, and has holes in the lower part in the shanks, through which a split is inserted. So long as the key-leaf remains in position, the other leaves cannot get off the main bar, as they cannot be moved sideways to the part of the bar where the bead is left off, which is the only place where the leaves can be removed.

By the use of these removable leaves, the cost of the renewal of the surface of the grate bars is reduced to a minimum. The old leaves can, when necessary, be broken off with a hammer, and new leaves put on the bar without removing it from the furnace.

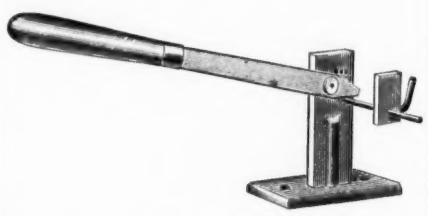
It will be noticed that the main part of the body bar is protected from the direct action of the heat, by the leaves coming closely together for some distance down the bar. In many of the ordinary rocking grates, the fingers, or projections from the main bar, are cast in one piece with it, consequently, with an intense fire on the fingers, the heat is transmitted directly to the main body of the bar, causing it to become warped and inoperative. In the grate bars here illustrated there is a slight amount of play between the leaves and the main bar, so that there is a film of air between the two, hence, it is claimed that the main bar cannot receive heat enough to warp it. Again, as each leaf is loose, any tendency to warp is confined to the leaves themselves. This is claimed to be an important feature, and is said to add greatly to the durability of the bar.

Another feature developed from the use of removable leaves is that, when desirable, the size of air space can be changed by putting on another set of leaves; the main frame and other parts of the bars remain as before.

The frame is made in sections, which can be passed through the ash-pit or fire-door openings, and put together inside of the furnace. The frame stands on four legs, and is provided with suitable bearings for the trunnions on the bars; in fact, it is a complete apparatus itself, and can be placed in any rectangular furnace without altering it in any way.

Since with these bars the fire can be cleaned without opening the furnace door, the temperature in the furnace, during the time of cleaning the fire, will not be lowered, and cold currents of air cannot come in contact with the heated plates of the boiler, thereby subjecting the boiler to unequal strains which are liable to injure it.

Again, with the ordinary way of cleaning, all of the clinkers are thrown on top of the fire, and, in many cases, some of them adhere to the walls of the furnace or bridge wall, and re-lining of the furnace is the consequence, which, with the use of the bars here illustrated, is avoided. It is also claimed that these bars will burn the fuel to the best advantage.



Wire Cutter.

The engraving accompanying this is of a wire cutter which is manufactured by R. M. Clough, Meriden, Conn. It is intended either to be bolted to the bench or held in an ordinary machinist's vise, and will cut wire up to $\frac{1}{4}$" diameter. The base is made of cast-iron, to which is bolted the cutting plate of cast-steel, $\frac{5}{8}$" thick. Through this plate are drilled four holes for wire of different sizes, and they are so located with reference to the center upon which the cutting lever turns that a shearing cut is obtained. The lever is made of cast-steel. A gauge is provided which will gauge pieces up to 6" in length, or longer if desired. Larger machines are also made by the same maker.

The Public Library of the City of Milwaukee contains the last ten volumes of the AMERICAN MACHINIST in bound form, and the Secretary, Mr. K. A. Linderfelt, desires to procure for the institution the first two volumes, bound, or in condition for binding. Who can accommodate him?

Improved Galvanizing Process.

By a new and interesting process, zinc is now applied to iron in such a manner as to prevent liability of the zinc becoming detached, besides imparting to the metal the property of taking a polish or being galvanized with any desired metallic coloring. In accomplishing this result, the iron is first cleaned by being subjected to the action of a mordant, after which it is drawn through a solution of chloride of zinc, a little ammonia is thrown upon it, and immersion in the zinc bath follows. The apparatus for this purpose is placed near the heating appliance, being so constructed that two rotating cylinder brushes are placed over the vessel containing the zinc, and can be brought nearer to or removed from each other in a horizontal position, even during their rotation. When the iron plate is to be placed in the zinc bath, the brushes are moved sufficiently far apart to allow of this being easily done. The iron remains in the bath until it has assumed the temperature of the contents; the metal is then lifted out of the bath sufficiently for its upper portion to reach the middle of the steel cylindrical brushes, which are put into rotary motion by the mechanism, and are brought so near each other that both sides of the metal are subjected to their action. Their velocity is regulated by their distance from the surface of the zinc bath, and by the thickness of the metal to be treated. The superfluous zinc is removed by the brushes, while in a soft condition, so that only the clean zinc-alloyed layer is visible after the operation. This layer is not a coating of zinc, but is the original surface of the iron, and therefore inseparable from it. Not only does it perfectly resist all influences of temperature, but it can be heated without injuring the layer of iron and zinc-alloy.—*The Engineer and Iron Trades Advertiser.*

On the Tidal Wave of Prosperity.

As this seems to be a day of brag and bluster with newspapers, we will remark that if our circulation continues to increase we will have to run our power press twice as fast as usual, even if we have to hire two niggers to do it.—*Hartwell (Ga.) Sun.*

Machinists' Supplies and Iron.

NEW YORK, August 16, 1890.

Iron—American Pig—The market has undergone no change of note, and the market has ruled quiet. Some pretty liberal concessions are understood to have been made by at least one Southern producer. Northern No. 1 iron seems to be comparatively plentiful, as is also the case with some brands of Southern Soft irons.

We quote Northern No. 1 Foundry, $17 to $17.50; No. 2, $16 to $17; Gray Forge, $15 to $15.25; Southern No. 1, $16.50 to $17.25; No. 1, Soft, $16.50 to $16.75; and No. 2, $15.75 to $16.

Scotch Pig—The demand has been moderate. We quote Eglinton, $19.25 to $19.75; Dalmellington, $21 to $21.50; Coltness, $23.50 to $24.

Bar—The demand has been fairly good, and the market firm.

We quote Common, $1.85; Medium, $1.90; Refined, $1.95 to $2 for round lots on dock.

Copper—No change of importance has taken place, and while producers do not seem anxious to make contracts, and prices are steadily maintained, consumers seem equally indifferent, and apparently are able to control all the supplies needed for immediate use. Lake is quoted at 17c.; Arizona Ingot, 15c.; casting brands, 14¾c.

Lead—The market has been firm, the offerings from the West being somewhat lighter. Values are at about 4.50c.

Spelter—The supply seems less plentiful, and prices are firmer. In carload lots sales are reported at 5.5c., though future deliveries are quoted lower.

Tin—The demand has been rather slow, and speculative interest has declined somewhat. Values range at 21c. to 21.30c.

Antimony—The demand has been moderate, and there is no quotable change in prices of Regulus. We quote Hallett's, 20¼c. to 20¾c.; Cookson's, 23½c.

Lard Oil—The demand is moderate, and it is selling at 49c. to 50c. for prime.

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"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—A job to design and construct some new machine. Address Expert, AM. MACHINIST.

Wanted—Irregular die makers. Address Ferracute Machine Co., Bridgeton, N. J.

Wanted—Position in machine shop; ten years' experience in office and shop. H. S., AM. MACHINIST.

Draftsman with practical shop experience wants position in N. Y. or vicinity. Box 65, AM. MACHINIST.

Wanted—Exp'd foreman for machine shop. Address, with particulars, W., 116 S. Clinton st., Chicago.

Wanted—An experienced draftsman on structural and architectural iron work. Address Box 60, AMERICAN MACHINIST.

Spindle and flyer maker; good; 26; Englishman; wants situation anywhere. Address Active, 310 E. Broadway, N. Y. City.

Wanted—Position by mch. shop supt. or foreman; large exp. on heavy, light, automatic and interchangeable mach'y. Address Box 64, AM. MACHINIST.

Pattern makers wanted in wood shop and in our metal room; state experience and pay wanted. Illinois Malleable Iron Co. Chicago.

A pattern maker desires position by Sept. 1st, engine or machine work pref'd; A1 ref. character and ability. Address Competent, AM. MACHINIST.

A man well qualified to draw and design special machinery, small tools, jigs, etc., and with some experience in handling men, wants employment. Address "R. 32," AMERICAN MACHINIST.

Wanted—A foreman for an established boiler shop, employing 60 to 100 men, located in Pennsylvania. Apply, stating age, experience and references, Box 61, AMERICAN MACHINIST.

Mechanical engineer and draftsman, with ten years experience in designing steam engines and general machinery, wishes to change. Address Box 63, AM. MACHINIST.

Wanted—As foreman, an experienced and practical man in the manufacture of milled machine screws, etc., for shop in Canada. State salary; references required. Address Box 62, AM. MACHINIST.

Wanted — Good machinists; vise or machine hands; steady work and good wages to first-class men Address Frick Company, Waynesboro, Franklin Co., Pa.

Wanted—A boiler-shop foreman, capable of handling one hundred men on marine work. Write, stating terms and giving references, to Box 55, AMERICAN MACHINIST.

Machinists Wanted—First-class floor hands and fitters of large experience and of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, O.

Wanted—Machinists and metal pattern makers; a steady employment given to capable men; works are being greatly enlarged; town near Chicago, is rapidly growing and has an excellent climate. Haxtun Steam Heater Co., Kewanee, Ill.

Wanted—Fifteen or twenty experienced molders, to make heavy and light casting; state experience, habits, age, and class of work preferred. Steady employment to good men. Address The Canton Steam Pump Co., Canton, Ohio.

Wanted—A foreman for Blacksmith and Hammer Dept's, at Pittsburgh Locomotive Works, Pittsburgh, Pa. Must be temperate and thoroughly understand the business. State wages expected, and address applications to the Company.

Wanted—Vise hands and fitter on turret lathe work. Steady work to A1 workmen of good habits; new shop with modern tools and sanitary arrangements. Jones & Lamson Machine Co., Springfield, Vt.

Wanted—To add to office force in large shops in Chicago, one or two draftsmen experienced in Corliss and general engine designing, also one or two draftsmen experienced in mill building, constructions and general machinery. Address Box 40, AMERICAN MACHINIST.

Wanted—A competent machinist to do light accurate work on the lathe or vise as required; must be steady and reliable. To the right man will be offered a good place in a comfortable shop doing a variety of work. Address "Machinist," care AM. MACHINIST.

Wanted—Three or four good machinists for engine and job shop; also one working foreman moulder or man to run foundry labor on the tonnage system, making machinery castings in green, dry, and loam sand; this is a good chance for a man suitable for the place. Address at once, Kenney & Co., Scottdale, Pa.

Wanted—Foreman for our pattern shop, a pattern maker who is master of his trade, who has a good education and a thorough understanding of drawings, and who has had experience in architectural iron work; a permanent position and a good salary to a competent man. Address The Snead & Co. Iron Works, Louisville, Ky.

Wanted—Superintendent to take charge of a small shop in England; must thoroughly understand manufacture of small lathes and milling machines on proper system. Good tools (American) and every facility. Permanent situation to really first-rate man. Apply with full particulars of experience and salary required, to Alfred Herbert, Grosvenor Road, Coventry, England.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

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Wanted—Customers for our new Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

Complete list of our Scales and other new tools for 2c. stamp. A. T. Koopman, Chicago.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

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Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

R. G. & Co. having secured the American Patent for their Fuel Economizer for Steam Boilers would be glad to treat with some good firms as to agency for same. R. Gosling & Co., Hadleigh, Eng.

For sale—Whole or part of foundry and machine works in good town in Indiana gas regions; good buildings, suitable for any kind of manufacturing. T. M., 9 Whippo street, New Castle, Penn.

Wanted—Engineers to write for Catalogue of all the latest and most valuable mechanical, scientific and electrical books which are given free with each barrel of the Pittsburgh Boiler Scale Resolvent. Pittsburgh Boiler Scale Resolvent Co., Pittsb'gh, Pa.

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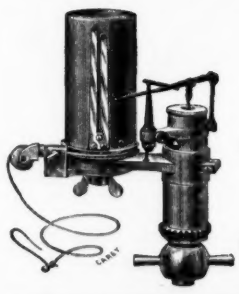

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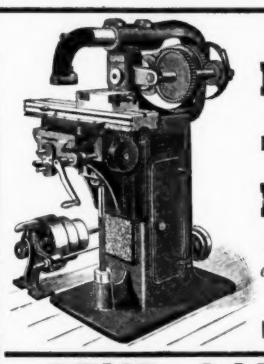

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9	1 3-8	.95
10	1 1-2	.95
11	1 3-4	1.10
12	2	1.30
13	2 1-4	1.35
14	2 1-2	1.45
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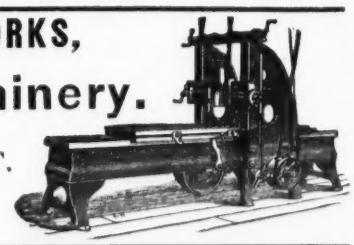

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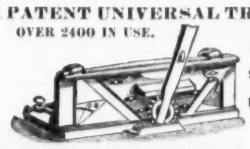

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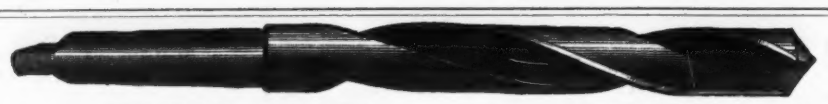

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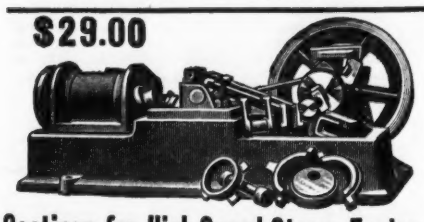

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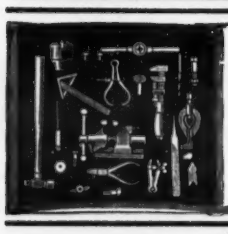

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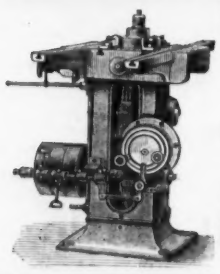

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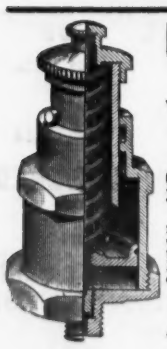

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The following list is published to facilitate the ordering of back numbers containing them. Any of these issues can be ordered through any newsdealer, or of the publishers direct, at the price then ruling, viz.: 5 Cents a Copy.

1886.

Pattern Making. Various Articles on. By F. W. Barrows. Appearing in 29 issues.
Foundry Practice, Various Articles on. By Robt. E. Masters, appearing in 16 issues.
Strength of Different Mixtures of Cast-iron and Method of Testing. By Robt. E. Masters, April 24.
Foundry Practice, Articles on. By Foundryman. [L. C. Jewett.] Aug. 14, Sept. 25, Dec. 18.
Foundry Practice, Articles on. By S. Bolland, May 8, 22 29, June 26, July 10.
The Morton-Poole Roll Grinding Lathe. By Joshua Rose, J. G. Tramis, Geo. H. Babcock and C. A. Smith, July 3, 24, Aug. 7, 14, 21, Sept. 25.
Machine Shop Cost and Time Accounts. By A. J. Shaw, Henry Metcalfe and C. A. Burton, April 3, 17, May 8.
Tests of Iron. By David Spence, April 17, Oct. 30
Traction on Grades. By A. B. Ropes, Oct. 30.
Wilson's Valve Gear for Locomotives, Oct. 30.
Casting Face-plates Face Up. By David Spence, Oct. 23.
A Job of Shaft Straightening. By F. L. Johnson, Oct. 23.
Inventory Valuation of Machinery Plant. By Oberlin Smith, Aug. 7.
Making a Cast-iron Sheave. By P. S. Dingey, July 31.
New Dredge Boiler designed by Norman Wheeler, July 17.
Core Oven with Rotating Back. By Thos Wathey, July 24.
Universal Table for Lathe Change Gears for Screw Cutting. By Joshua Rose, July 24.
Gating, Clamping and Securing Chaplets. By Matthew Wiard, May 1.
Printing Frame and Manner of Making Blue Prints. By C. L. Redfield, July 31.
Some Pressure Tests. By C. O Sine, Nov. 27.
An Expanding Mandrel—Turning Tapers. By Chas. S. Beach, Nov. 27.
Core Making in Foundries. By David Spence, Nov. 20.
Making Pattern for Spiral Grooved Drum. By Geo. Allge, Aug. 14.
Rolling Conic Sections Applied to Gears. By Geo B. Grant, Nov. 6.
Ninety-inch Belpaire Fire-box Boiler, Nov. 6.
Spacing in the Milling Machine. By Chas. S. Beach, Aug. 21.
Engine Crossheads. By J. G. Tramis, Aug. 21.
Traction and Adhesion. By A. B. Ropes, Aug. 28.
Internal Key-seating on Milling Machines. By A. B Landis, April 17.
Tapping Holes in Boilers. By A. B. Landis, April 24.
How to True Emery Wheels. By L. Best, April 24.
Work and System in the Drawing-room. By C. L. Redfield, Aug. 28.
Oiling Lathe Carriage Ways. By Wm. H. Bradt, Aug. 28.
Moulding a Screw or Worm without Cores. By George Allge, Sept. 11, 18.
Power Absorbed in Cutting Cast-iron. By James F. Hobart, Sept. 11, 18.
Moulding Screw Propellers in Loam. By Chas. A. Devlin, Sept. 18.
Dimensions of Wrought iron Pipes in England. By A. G. Brown, Sept 4.
Truing Up and Replacing Milling Machine Centers with Accurate Alignment. By A. B. Landis, Jan. 16.
Methods of Working and Tempering Steel. By S. W. Goodyear, Jan. 9.
Slotting Tool. By J. J. Bingley, May 8.
How to Make Clean Solid Castings at Least Possible Cost. By Matthew Wiard, April 10.
Truing Milling Machine Centers. By W. R. Ballou, April 10.
Lining Engine Lathes. By Chas. S. Beach, April 10.
Steam Piping. By J. G. Tramis, April 10.
An Equalizing Dog. By A. B. Landis, April 10.
Screw Cutting Dies. By John J. Grant, April 10.
Some Handy Shop Tools. By Fred. H. Colvin, April 3.
Moulding Bells for Blast Furnaces in Green Sand Without Patterns. By Geo. O. Vair, April 3.
Furnace for Heating Long Bars. By W. G. Richards, April 3.
Cutting Tools—Roll Turning. By S. W. Goodyear, Oct. 16.
Hydraulic Forging. By J. Richards, July 10.
A "Box" Jig. By C. E. Simonds, June 19.
Cheap Testing Machine. By Wm. Merrill, Feb. 6.
Boring Deep Holes. By A. B. Landis, Mar. 27, May 8.
Working Steel and Iron. By S. W. Goodyear, Feb. 13.
Inventory Valuations of Patterns. By W. E. Matheson and others, Jan. 9, Feb. 13, 20, Mar. 6.
Making Cast-iron Half Boxes. By A. J. Shaw, Feb. 6.
Draining Steam Pipes. By W. E. Crane, Feb. 6.
Brazing and Welding Iron. By J. F. Hobart, Mar. 6.
Deep Holes by Continuous Boring. By A. B. Landis, Mar. 27.
Slotting Machine Tool. By Wm. Foster, Mar. 20.
Compound Engines for Stationary or Factory Purposes. By W. H. Hoffman, April 24, May 1, 22.
Engineering Subjects, Articles on. By W. H. Hoffman, Mar. 13, July 24, 31, Aug. 21, Oct. 9.
Self-contained Engines. By W. H. Hoffman, Feb. 27, Mar. 6.
Curving Qualities of Locomotives with High and Low Centers of Gravity, Oct. 16.
Making Large Spur Gear Wheels. By P. S. Dingey, Oct. 2.
Normal Theory of the Gear Tooth Curve. By Geo. B. Grant, Mar. 13, 20, Oct. 9.
Return Tubular Boilers. By Wm. Lowe, Nov. 27, Dec. 4.
Chimneys for Steam Boilers. By Wm. Lowe, Mar. 27, May 15. By F. A. Halsey, May 1.
Railroad Cost Cards and Expense Sheets, April 24
The Milling Machine—Its Construction and Uses. By John J. Grant, Mar. 20.
Mechanical Arrangements of the N. Hudson County Cable Railway, Mar. 20.

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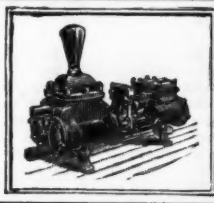

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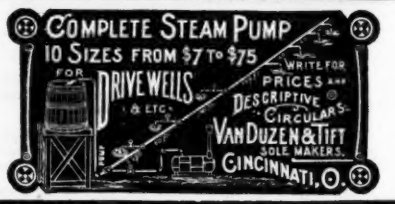

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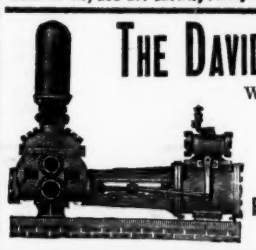

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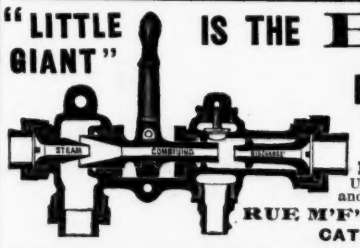

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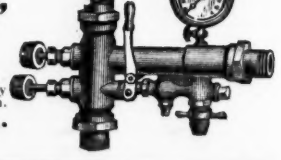

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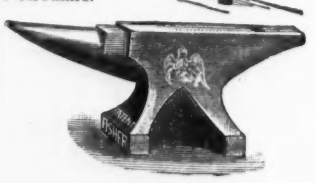

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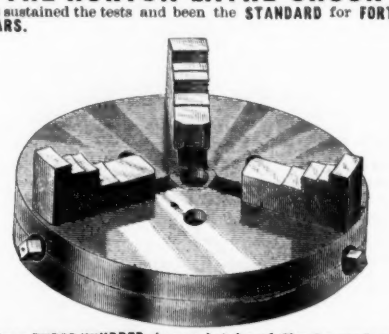

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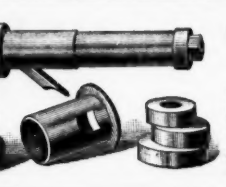

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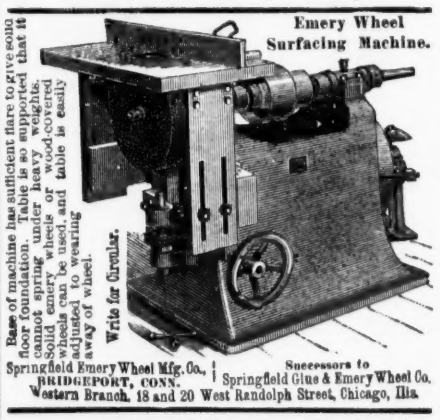
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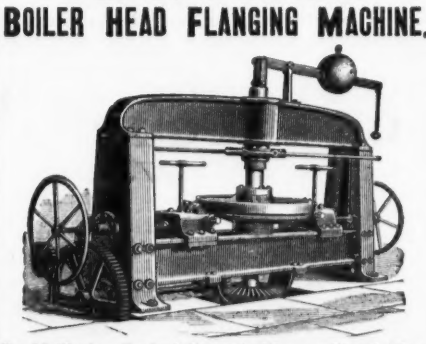

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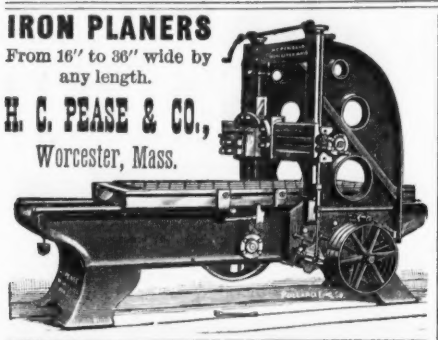

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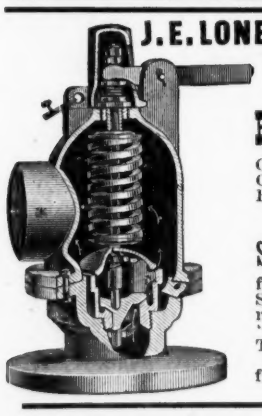

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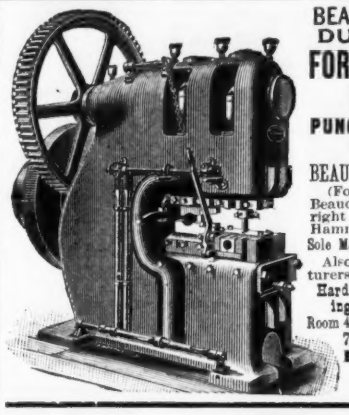

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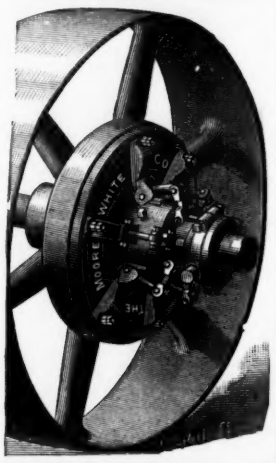

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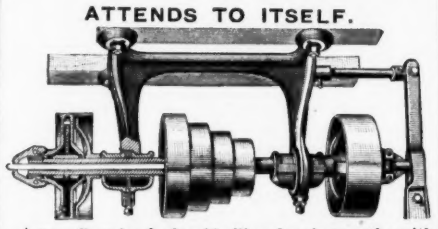

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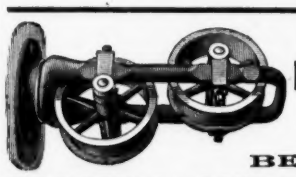

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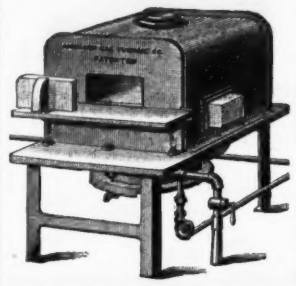

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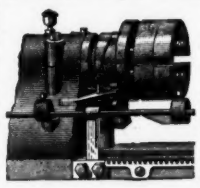

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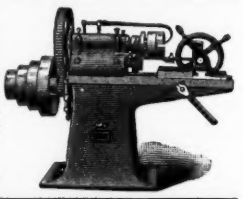

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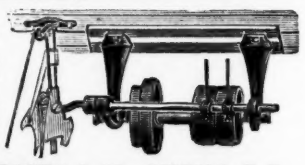

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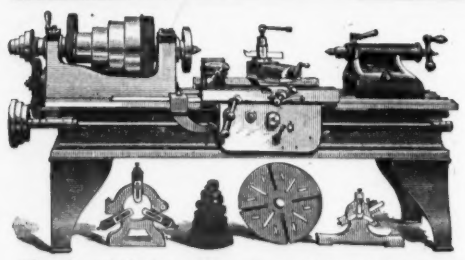

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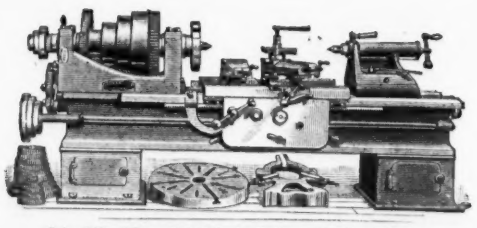

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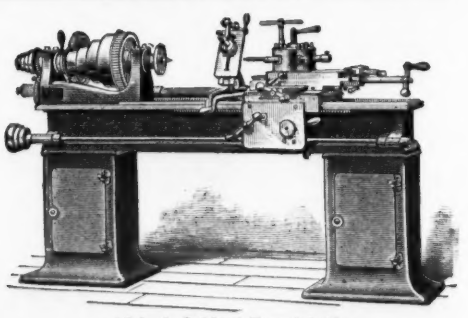

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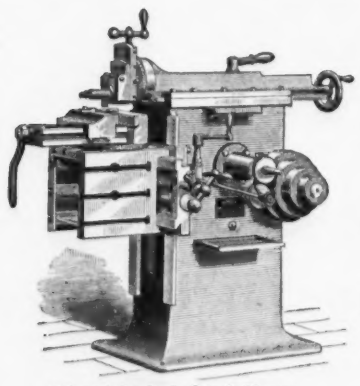

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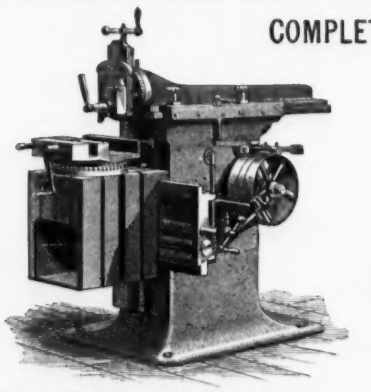
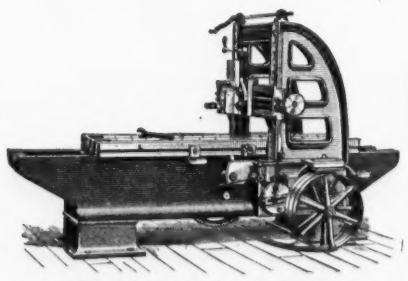


20, 26 and 32-inch Triple Geared Shapers.
Stroke changed while machine is running. Shaft can be passed through head of machine and key seat cut in same to any length. Extra heavy vises. Tables slotted on all sides.



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Extra deep beds and tables. Powerfully geared. Plenty of Metal and designed for extra heavy duty. All Feeds and Shipper operated from both sides.
Improved Device for holding Planer Bolts.

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MILLING MACHINES
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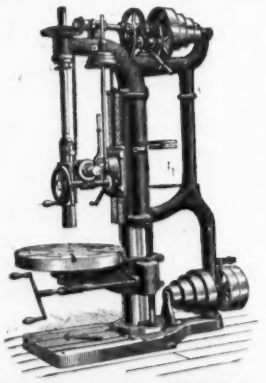

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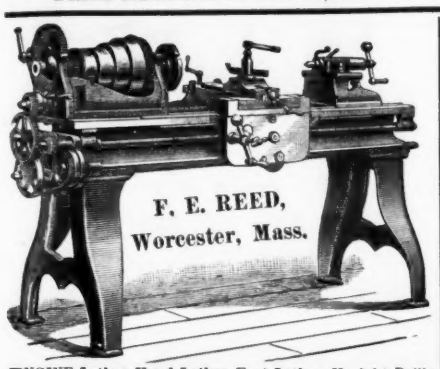

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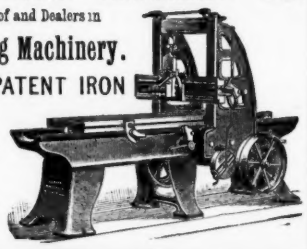

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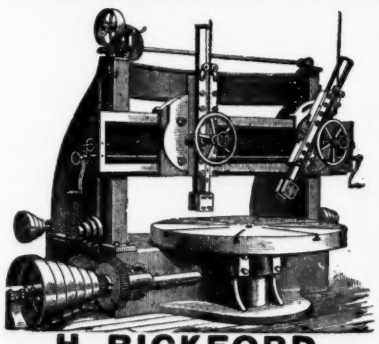

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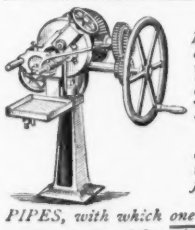

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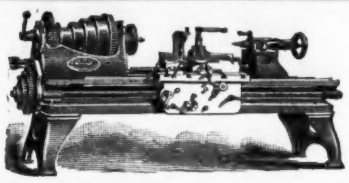

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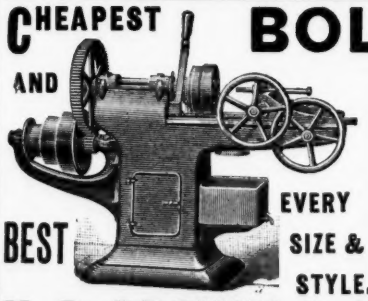

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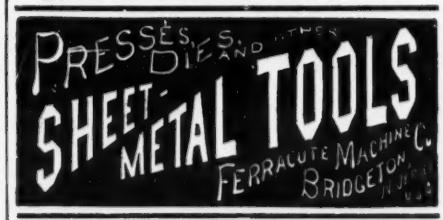

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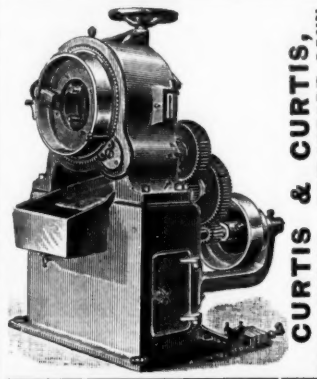

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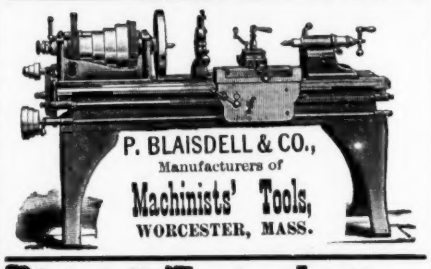

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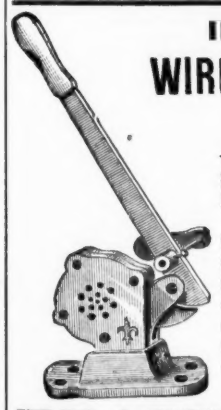

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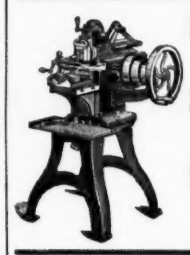

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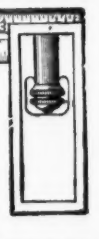

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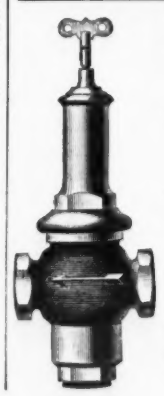

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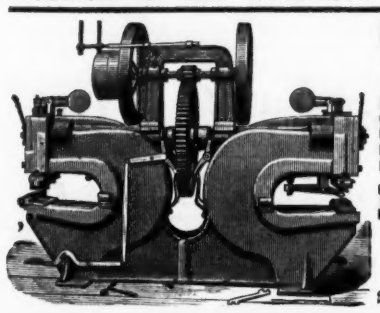

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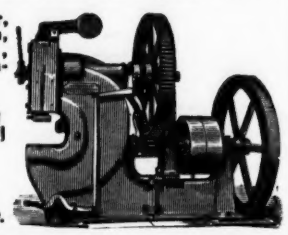

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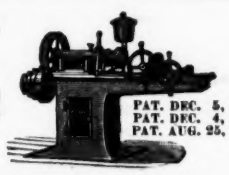

PAT. DEC. 5, 1882.
PAT. DEC. 4, 1883.
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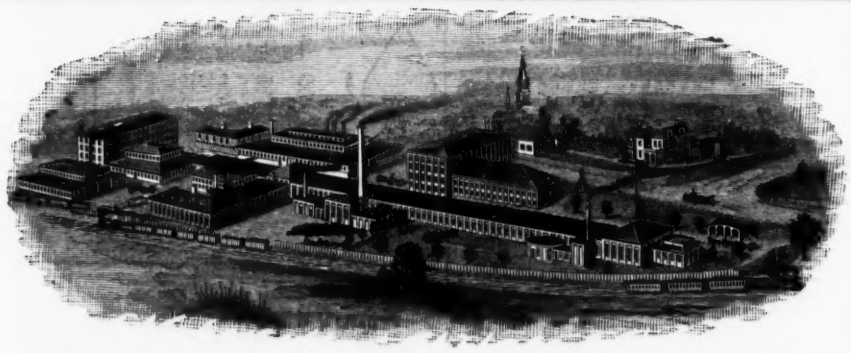

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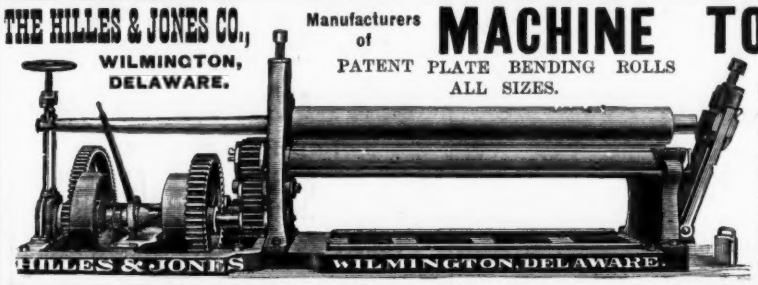

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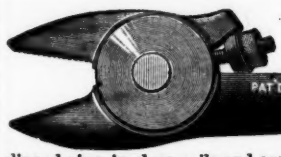

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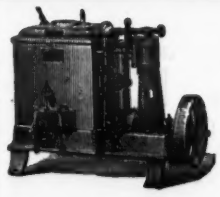

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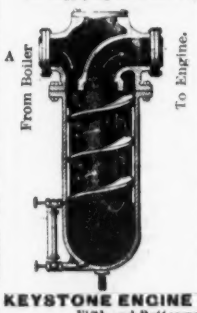

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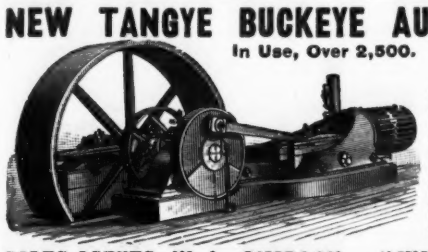

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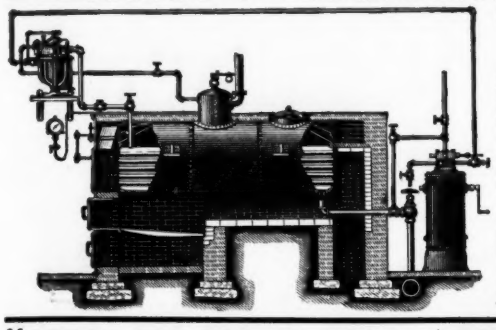

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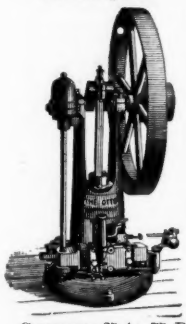

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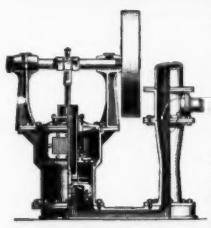

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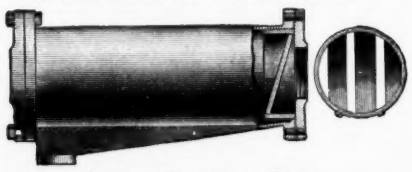

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Wood & Light,	" "	20 in. "	7 1-2 ft. "
Townsend	" "	21 in. "	7 ft. "
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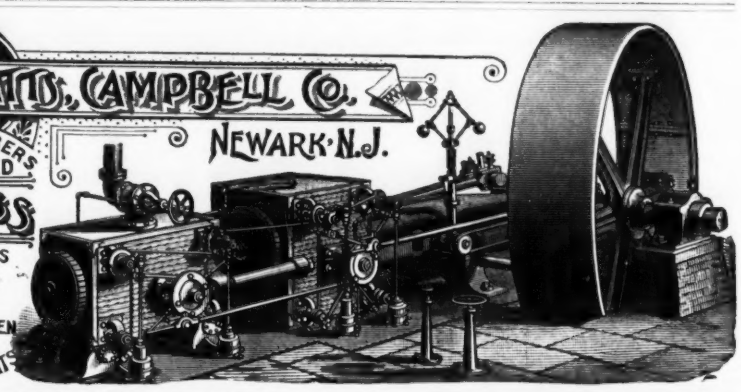

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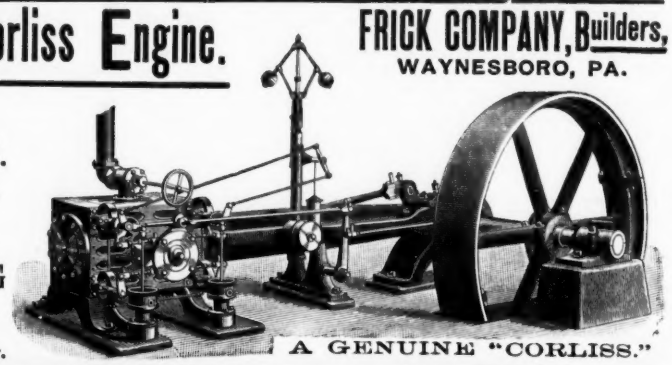

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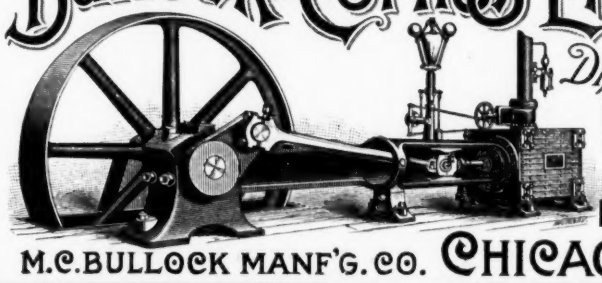

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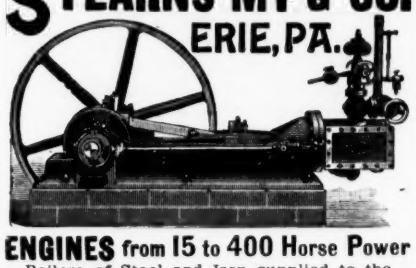

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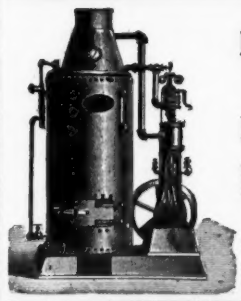

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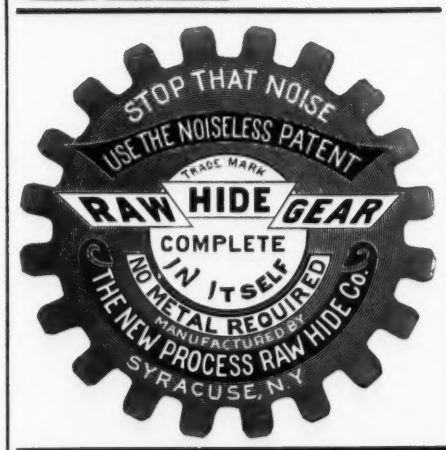

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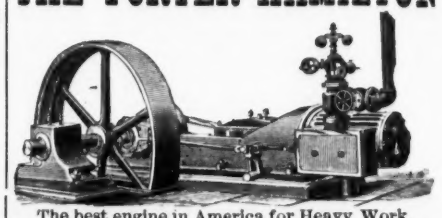

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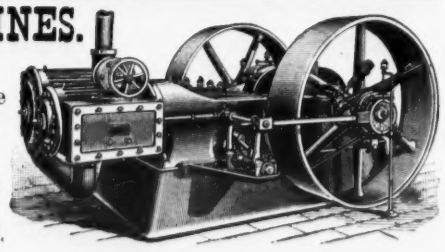

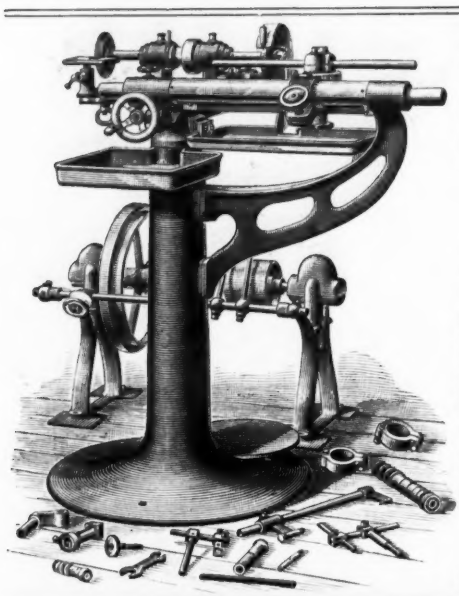

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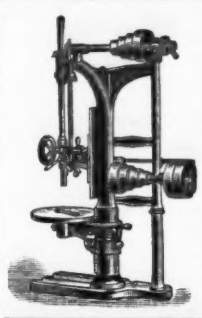

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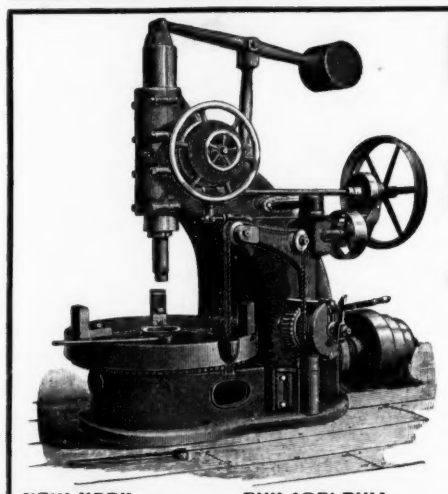

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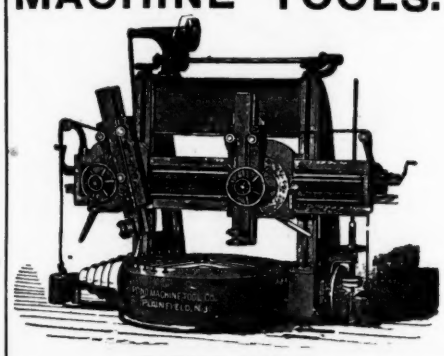

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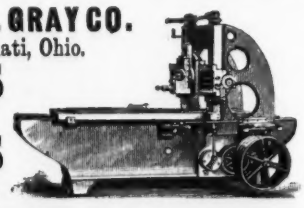

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